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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

1-1320. Bayrock, L. A. GLACIAL GEOLOGY OF THE ALLIANCE DISTRICT, ALBERTA, CANADA: Research Council Alberta, Geol. Div., Prelim. Map 57-2A, scale 1 in. to 1 mi., 1958.

Glacial deposits of the area are mainly ground moraine. Kames, crevasse fillings, stream trenches, glacial lakes, and outwash deposits are of minor importance. All glacial features of the area are of stagnant ice origin. The area is crossed more or less from the W. to the E. by the Gwynne outlet (the Battle River valley) which drained Lake Edmonton. At one time the waters of the outlet overflowed the banks in the area and eroded away the surface material of an area of more than a township. Recent modifications are limited only to slumping of the banks of the Battle River valley and some minor badland development. Aeolian deposits are of minor importance and are found only on outwash sand. --Auth.

1-1321. Bayrock, L. A. GLACIAL GEOLOGY OF THE BROWNFIELD DISTRICT, ALBERTA, CANADA: Research Council Alberta, Geol. Div., Prelim. Map 57-2B, scale 1 in. to 1 mi., 1958.

About half of the area is covered by hummocky dead-ice moraine. The moraine is of stagnant ice origin and consequently it does not signify any halt of the ice. Its main features are prairie mounds, knobs and kettles, moraine plateaus, and crevasse filling. The moraine is gradational into ground moraine to the W. In the E. the boundary of the moraine is well defined. Stream trenches, which are also of stagnant ice origin, are common in the western half of the sheet. Recent modifications are limited mainly to slumping of the Battle River bands and to some infilling of kettle holes. --Auth.

1-1322. Bayrock, L. A. GLACIAL GEOLOGY OF THE GALAHAD DISTRICT, ALBERTA, CANADA: Research Council Alberta, Geol. Div., Prelim. Map 57-3A, scale 1 in. to 1 mi., 1958.

The whole area is covered by flat to gently undulating ground moraine. Occasional crevasse fillings made of till and small kames break the monotony of the landscape. Stream trenches are numerous in the eastern part of the sheet. The glacial history of the area is one of over-all stagnation of the last glacier. Recent modifications are limited to some infilling of kettle holes and other closed depressions. --Auth.

1-1323. Bayrock, L. A. GLACIAL GEOLOGY OF THE HARDISTY DISTRICT, ALBERTA, CANADA: Research Council Alberta, Geol. Div., Prelim. Map 57-3B, scale 1 in. to 1 mi., 1958.

Most of the features of the area were produced by extensive stagnation of the last glacier to cover the area. Hummocky dead-ice moraines are patchy and of irregular outline. Small outwash plains made up of sand and gravel are common in the eastern half of the sheet. Anastomosing stream trenches greatly modify the topography of the western half of the sheet. The Gwynne outlet, which drained Lake Edmonton, crosses the area from S. to N. It has associated with it large terraces capped by sand and gravel. Aeolian sand of recent origin covers large tracts of land in the northeastern part of the sheet. --Auth.

1-1324. Durham, D. L., and Robert F. Yerkes. GEOLOGIC MAP OF THE EASTERN PUENTE HILLS, LOS ANGELES BASIN, CALIFORNIA: U. S. Geol. Survey, Oil & Gas Inv. Map OM-195, scale 1:24,000, 1959.

The mapped area covers about 130 sq. mi. on the NE. margin of the Los Angeles Basin, including all or part of 4 oil fields along and S. of the Whittier fault zone and 2 small producing areas in the Puente Hills N. of the fault zone. Surface structural features are shown on the map, which is accompanied by a list of wildcat wells with selected producing wells and a brief text discussing revised stratigraphic names. --U. S. Geol. Survey.

1-1325. Crawford, Thomas J., Daniel J. Jones, and Edmund Nosow. PRELIMINARY OIL AND GAS MAP, TAYLOR COUNTY, KENTUCKY: Kentucky Geol. Survey, Ser. 10, scale 1:48,000, May 1959.

This map was prepared primarily to show the general trend of oil and gas exploration and development in the area. Three hundred fifty-eight wells are located and identified by farm name; operator, elevation, and total depth of the wells are given where known. The base map of Taylor County was adapted from recent U. S. Geological Survey 7.5 minute planimetric sheets and provides an accurate base for continuing oil and gas investigations in the County. --T. J. Crawford.

1-1326. Ponsetto, Louis R. COAL MINE MAP OF EASTERN KENTUCKY: Kentucky Geol. Survey, Ser. 10, graphic scale approx. 1:280,000, 1958.

Map shows location of coal mines producing more than 5,000 tons in 1957. Coal mines are symbolized as to type: drift, strip, strip and auger, auger, slope, and shaft. These are further categorized as rail mines or truck mines. Approximately 950 mines are located. The base map was adapted from Kentucky transportation maps, U. S. Department of Commerce. Information was compiled in cooperation with the U. S. Geological Survey and Kentucky Department of Mines and Minerals.--T. J. Crawford.

1-1327. North Carolina Dept. of Conservation and Development, Division of Mineral Resources. GEOLOGIC MAP OF NORTH CAROLINA: scale 1:500,000, explanatory notes, 1958.

This is primarily an areal geology map, printed in color, on which the only structural features shown are a few major faults of regional significance. The rocks of the state are divided into 54 units some of which are true stratigraphic formations, but the majority are classed as rock units. In the explanation on the map these formations and rock units are placed as nearly as possible in the stratigraphic sequence in which they occur in the earth's crust, and each unit is described briefly.--J. L. Stuckey.

Explanatory text by J. L. Stuckey and S. G. Conrad is listed in this issue of GeoScience Abstracts under Pt. 2. Areal and Regional Geology.

1-1328. North Dakota Geological Society, Bismarck, North Dakota. NESSON ANTICLINE STRUCTURE MAP: scale 1 in. to 4000 ft., Jan. 1959.

A new map of the 70 mi. productive trend. This

map shows structural configuration by 25-ft. contours of the main Mississippian limestone pay interval, subsea elevation of 2 widely known mapping horizons for every well drilled and completed to Jan. 1959, initial production for each well, pre-Mississippian tests, combination log of the Mississippian to Precambrian section, and official field outlines. This contoured map is posted to Jan. 15, 1959. Uncontoured maps suitable for reproduction (sepia or mylar) posted weekly are also available. --North Dakota Geol. Soc.

Map was prepared by the Nesson Anticline Committee of the North Dakota Geological Society, consisting of: Jack B. Mills, Chairman, William Bolenbaugh, James S. Cantrell, Robert S. George, Gene O. Kennedy, William M. Pendleton, Jack W. Pierce, and K. W. Roth. The manual, Nesson Anticline of North Dakota, also prepared by this Committee, is listed in this issue of GeoScience Abstracts under Section 13. Fuels.

1-1329. Post, E. V., and D. W. Lane. PRELIMINARY GEOLOGIC AND STRUCTURE MAP OF THE NORTHEAST PART OF THE CASCADE SPRINGS QUADRANGLE, FALL RIVER COUNTY, SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-208, scale 1:7,200, contour interval 10 ft., lat. 43°20'-43°22'30"N., long. 103°30'-103°33'45"W., 1959.

1-1330. Post, E. V., and N. P. Cuppels. PRELIMINARY GEOLOGIC AND STRUCTURE MAP OF THE NORTHWEST PART OF THE CASCADE SPRINGS QUADRANGLE, FALL RIVER COUNTY, SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-207, scale 1:7,200, contour interval 10 ft., lat. 43°20'-43°22'30"N., long. 103°33'45"-103°37'30"W., 1959.

1-1331. Post, E. V., and D. W. Lane. PRELIMINARY GEOLOGIC AND STRUCTURE MAP OF THE EAST-CENTRAL PART OF THE CASCADE SPRINGS QUADRANGLE, FALL RIVER COUNTY, SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-210, scale 1:7,200, contour interval 10 ft., lat. 43°17'30"-43°20'N., long. 103°30'-103°33'45"W., 1959.

1-1332. Post, E. V., and N. P. Cuppels. PRELIMINARY GEOLOGIC AND STRUCTURE MAP OF THE WEST-CENTRAL PART OF THE CASCADE SPRINGS QUADRANGLE, FALL RIVER COUNTY, SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-209, scale 1:7,200, contour interval 10 ft., lat. 43°17'30"-43°20'N., long. 103°33'45"-103°37'30"W., 1959.

1-1333. Post, E. V. PRELIMINARY GEOLOGIC AND STRUCTURE MAP OF THE SOUTHEAST PART OF THE CASCADE SPRINGS QUADRANGLE, FALL RIVER COUNTY, SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-212, scale 1:7,200, contour interval 10 ft., lat. 43°15'-43°17'30"N., long. 103°30'-103°33'45"W., 1959.

1-1334. Post, E. V. PRELIMINARY GEOLOGIC AND STRUCTURE MAP OF THE SOUTHWEST PART OF THE CASCADE SPRINGS QUADRANGLE, FALL RIVER COUNTY, SOUTH DAKOTA: U. S. Geol. Survey, Mineral Inv. Map MF-211, scale 1:7,200, contour interval 10 ft., lat. 43° 15'-43°17'30"N., long. 103°33'45"-103°37'30"W., 1959.

1-1335. Davidson, Edward S., and R. A. Cadigan. PRELIMINARY GEOLOGIC MAP OF THE CIRCLE CLIFFS 1 NE QUADRANGLE, GARFIELD COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-153, scale 1:24,000, contour interval 40 ft., lat. 37°52'30"N., long. 111°-111°07'30"W., 1959.

1-1336. Brown, G. F., and R. O. Jackson. GEOLOGIC MAP OF THE TIHAMAT ASH SHAM QUADRANGLE, KINGDOM OF SAUDI ARABIA: U. S. Geol. Survey, Misc. Inv. Map I-216A, scale 1:500,000, lat. 16°-20°N., long. 39°-42°E., 1958, pub. 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geophysics 1-1449; Mineralogy 1-1475; Geohydrology 1-1528, 1-1530, 1-1531; Mineral Deposits 1-1543, 1-1552; Fuels 1-1569.

1-1337. Benoit, F. W. PRELIMINARY REPORT ON ST. SYLVESTRE - ST. JOSEPH (WEST HALF) AREAS, ELECTORAL DISTRICTS OF MÉGANTIC, LOTBINIÈRE, DORCHESTER AND BEAUCE: Quebec, Dept. Mines, Prelim. Rept. no. 359, 10 p., fold. geol. map (Prelim. Map no. 1214), scale 1:63,360, 1958, 7 refs.

The area, mapped in 1956 and 1957, covers approximately 630 sq. mi. about 35 mi. S. of Quebec City (46°15'-46°30'N. 70°30'-70°45'W.), primarily within the Appalachian uplands. Consolidated rock is Paleozoic and includes Cambrian and Ordovician sedimentary and volcanic(?) rock, post-Cambrian gabbroic rock, and post-Ordovician serpentinites and acidic intrusives. Recent alluvium and glacial deposits are abundant. The Sutton anticline is here an anticlinorium, the axis of which passes through the eastern and southern parts of the map-area. It plunges gently (0°-20°) southwestward. Deposits of asbestos, molybdenite, talc, and granite are very briefly described. --A. C. Sangree.

1-1338. Bérard, Jean. PRELIMINARY REPORT ON LEAF LAKE AREA, NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 384, 7 p., fold. geol. map (Prelim. Map no. 1272), scale 1:63,360, 1959, 4 refs.

The 642-sq. mi. area at 58°30'-59°N. 69°45'-70°15'W. was mapped in summer 1958. It lies about 75 mi. N. of Fort Chimo. The region is roughly bisected from N. to S. by the contact (unconformity) between the Archean granitic gneisses to the W. and the Proterozoic rocks of the Labrador geosyncline to the E. The western half of the area, underlain by the basement rocks, is a uniform plateau cut by the valley of the Leaf River. In the eastern half the topography is diverse as is the structure and nature of the rocks. The Archean basement rocks consist primarily of granodiorite or granodiorite porphyry with inclusions of biotite schist or hornblendic rocks. Proterozoic rocks include sedimentary and metasedimentary rocks and metagabbro intrusives. A thin layer of Pleistocene till covers much of the area; erratics are numerous. Many faults were observed. The Proterozoic rocks near the contact with the Archean basement dip gently E. The dips increase eastward until rocks become

complexly folded and overturned to the W. Tight overturned folds occur in the southeastern quadrant. N. of Leaf Lake there are numerous open folds. Many sulfide zones have been recognized. Fe formations N. of Finger Lake and near Red Bay average 30% of recoverable Fe in the form of magnetite, hematite, and siderite. A large tonnage of low-grade Bessemer quality ore lies here, close to the sea. A talc schist zone about 25 ft. thick is distributed over a wide area. --A. C. Sangree.

1-1339. Bergeron, Robert, and G. H. Beall. PRELIMINARY REPORT ON LOUVIGNY-BOCHART AREA, ROBERVAL ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. 365, 8 p., fold. geol. map (Prelim. Map no. 1220), scale 1:63,360, 1958, ref.

The 200-sq. mi. area, mapped in summer 1957, lies about 60 mi. NW. of Lake St. Jean (49°-49°15'N. 73°15'-73°30'W.). Outcrops are relatively rare in a heavily wooded and drift-covered terrain. Precambrian Grenville-type gneisses underlie the area, except for 2 small masses of metagabbro and many small pegmatite dikes. The general structural trend is northerly. At least one major syncline, trending N., can be traced. Minor flow folds can be seen in many outcrop areas. A few shear zones were noted in the gneisses, but no evidence of displacement along them was found. Joints of various attitudes were recorded. General strike of foliation in the gneisses is NNW.; trends of lineation average about S. 25°E., the plunge being 30° to the SSE. No occurrences of economic minerals are known. Sand and gravel deposits are abundant, and many are being used for road and railway construction. --A. C. Sangree.

1-1340. Brown, W. G. PRELIMINARY REPORT ON THE NORTHEAST QUARTER OF FIEDMONT TOWNSHIP, ELECTORAL DISTRICT OF ABITIBI-EAST: Quebec, Dept. Mines, Prelim. Rept. 364, 12 p., fold. geol. map (Prelim. Map no. 1218), scale 1:24,000, 1958, 8 refs.

The area, mapped in 1957, is in northwestern Quebec S. of the village of Barraute (approx. 48° 26'N. 77°38'W.). All consolidated rocks are Precambrian. Oldest are Keewatin-type andesites, dacites and basalts. Post-Keewatin-type intrusive rocks include diorite, quartz diorite, feldspar porphyry, albite granite, intrusive rhyolite, biotite-hornblende granodiorite, and hornblende monzonite. A Keweenawan-type quartz diabase crops out in a series of interrupted dikes near the western boundary of the map-area. Pleistocene lacustrine clays, till, sand, and gravel mantle most of the area. Shape of the intrusive bodies, folding, shearing, and faulting are briefly described. Three types of metallic mineral deposits occur: Au-bearing quartz veins; pyrrhotite-sphalerite-chalcopyrite replacement deposits with a low content of Au; and pyrite-sphalerite deposits with a high tenor in Au. Brief descriptions of 6 mining properties are given. --A. C. Sangree.

1-1341. Gélinas, Léopold. PRELIMINARY REPORT ON THEVENET LAKE AREA (EAST HALF), NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept. 363, 7 p., fold. map (Prelim. Map no. 1215), scale 1:63,360, 1958, 3 refs.

The area, mapped in summer 1956, covers 160 sq. mi., about 30 mi. W. of Fort Chimo, including the eastern margin of the Labrador Trough (58°-58°15'N. 69°-69°15'W.). The area is underlain by Precambrian metamorphic rocks. The synclines are occupied by biotite schists, amphibole, pillowed amphibolite, carbonate rocks, and "granitic" gneiss. Rocks of the area belong, or are related to, rocks of the Labrador Trough. Youngest consolidated rocks are pegmatite dikes. Structure consists of a series of anticlines and synclines with northwestward-trending axes; few faults have been recognized. The contact between the gneisses and other rocks is generally marked by narrow depressions. Much of the northeastern quarter of the area is covered by sand marked by kettle lakes and kames. Iron formation in this region is in thin layers or lenses generally low in iron. --A. C. Sangree.

1-1342. Hogg, William A. PRELIMINARY REPORT ON NORTHEAST QUARTER OF MONTBRAY TOWNSHIP, ELECTORAL DISTRICT OF ROUYN-NORANDA: Quebec, Dept. Mines, Prelim. Rept. 389, 8 p., fold. geol. map (Prelim. Map no. 1276), scale 1:24,000, 1959, 2 refs.

The map-area comprises 25 sq. mi., 18 mi. NW. of the towns of Rouyn-Noranda and 5 mi. E. of the Quebec-Ontario boundary at 48°21'38"-48°25'N. 79°20'-79°24'15"W. Mapping was done during the summer of 1958. All consolidated rocks are Precambrian, and Keewatin-type volcanic rocks (andesite, dacite, rhyolite, basalt, and agglomerate) underlie most of the area. These rocks form easterly to northeasterly trending belts that have been folded into an E.-plunging anticlinal structure. Post-Keewatin-type intrusive rocks (diorite, gabbro, aplite, porphyritic syenite, and syenite) have invaded the volcanic formations. Late Precambrian N.- to NE.-trending diabase dikes are found particularly along the E. border of the map-area. Much of the low ground is covered by lacustrine clays, silt, and sand; many outcrops have been rounded by Pleistocene ice sheets, and small superficial deposits of ground moraine occur in some of the valleys. Some faults and shear zones are noted. No producing mines exist as yet within the limits of the map-area, nor has there been much exploration work. Disseminated pyrite is fairly common. No economic minerals have been found. --A. C. Sangree.

1-1343. Lachance, Leo. PRELIMINARY REPORT ON PLESSIS-LARTIGUE AREA, JONQUIÈRE-KÉNOGAMI ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 381, 6 p., fold. geol. map (Prelim. Map no. 1259), scale 1:31,680, 1959.

A brief geological study of this area, 20 mi. SW. of Chicoutimi, was carried out in July 1955 following a discovery which indicated the presence of Cu and Ni. Bedrock outcrops are relatively numerous for a heavily wooded and drift-covered area. Consolidated rocks are Precambrian. The formations were divided into 3 main groups listed from oldest to youngest: 1) granitic gneiss, 2) anorthosite, 3) granite. Cu and Ni mineralization was discovered in the altered zone immediately W. of the contact between the granite and anorthosite on the S. shore of Kenogami lake. This altered zone, some 3,500 ft. in width, is the only locality in the area in which encouraging amounts of mineralization were found. Results of trenching in this region are briefly described. The zone is worthy of further exploration work. --A. C. Sangree.

1-1344. Lespérance, Pierre J. PRELIMINARY REPORT ON SQUATECK AREA (WEST HALF), TÉMISCOUATA, RIVIÈRE-DU-LOUP AND RIMOUSKI ELECTORAL DISTRICTS: Quebec, Dept. Mines, Prelim. Rept. no. 385, 10 p., fold. geol. map (Prelim. Map no. 1273), scale 1:63,360, 1959.

The 245-sq. mi. area at 47°45'-48°N. approx. 68°45'-69°W. was mapped in summer 1958. All consolidated rocks are Paleozoic and sedimentary. A major period of deformation during the Ordovician separates the rocks into 2 groups, the Cambrian(?) and Ordovician Quebec group predating the deformation and the Silurian (and younger?) rocks that postdate it. Rocks have been modified by 2 periods of deformation, the Ordovician Taconic orogeny and the Devonian Acadian orogeny. Pleistocene glaciation has been responsible for numerous boulders and gravel deposits and probably for the extensive clay deposits. A major syncline and anticline are noted, also faults which are relatively common in the eastern part of the area. Occurrences of some metallic minerals, asbestos, clay, gravel, and limestone are very briefly described. --A. C. Sangree.

1-1345. McGerrigle, H. W. MADELEINE RIVER AREA, ELECTORAL DISTRICT OF GASPÉ-NORTH: Quebec, Dept. Mines, Geol. Rept. 77, 50 p., 15 illus. on 8 pls., geol. map (in pocket) scale 1:63,360, 1959, 23 refs.

The report deals with the geology of about 675 sq. mi. on the N. coast of Gaspé peninsula (approx. 48°-49°N. 65°-65°45'W.). Access and natural resources, topography and drainage are briefly described.

The region is underlain by shales, siltstones, sandstones, and limestones of Ordovician, Silurian, and Devonian age, the oldest in the N., the youngest to the S. Igneous intrusives, apparently all sills and dikes, are present in the western and middle thirds of the area. Although none of these are known to cut rocks younger than Lower to Middle Devonian, it is assumed that all are related to the Acadian orogeny of later Devonian time.

The area may be divided structurally into 2 parts. Ordovician rocks of the northern belt are strongly cleaved and complexly folded. Overturning of beds and block and thrust faulting are common. Silurian and Devonian formations of the southern belt are seldom cleaved, are openly folded, and are not overturned.

Cu deposits at the head of York River are associated with metamorphic effects from an underlying igneous intrusion. Host rocks of the deposits are altered limestones and calcareous siltstones of the Grande Grève and possibly the Cape Bon-Ami formations (Lower Devonian). Some 70,000,000 tons of ore averaging 1 to 2% Cu have been proven to date. Oil and gas possibilities appear to be slight except toward the southern borders. Beach deposits of Recent age provide sources of sand and gravel.--A. C. Sangree.

1-1346. Marleau, R. A. PRELIMINARY REPORT ON EAST MEGANTIC AND ARMSTRONG AREAS, ELECTORAL DISTRICTS OF FRONTENAC AND BEAUCE: Quebec, Dept. Mines, Prelim. Rept. no. 362, 7 p., 2 fold. geol. maps (Prelim. Maps no. 1216, 1217), scale 1:63,360, 1958, 6 refs.

The 340-sq. mi. area, mapped in summer 1957, lies about 100 mi. SE. of Quebec City, on the Quebec-Maine border. Consolidated rocks are Paleozoic and include a pre-Silurian crystalline complex of gray to dark-gray, fine-grained quartzose rock; Middle or Lower Devonian or Silurian black and gray slates and impure sandstones; and Middle or Lower Devonian quartzite, gray slates, and greenstones. Upper Devonian quartz-feldspar porphyry dikes intrude the metasedimentary rocks, and gabbroic sills of the same age intrude both the metasedimentary rocks and the greenstones. Flanks of the highest hills and the lower ground are covered by thick morainic deposits of Pleistocene age. Structural geology and occurrences of scheelite and Fe are very briefly described. --A. C. Sangree.

1-1347. Marleau, R. A. PRELIMINARY REPORT ON PERCHE-POITOU AREA, PONTIAC ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 383, 8 p., fold. geol. map (Prelim. Map 1274), scale 1:63,360, 1959, 3 refs.

The map-area, examined in summer 1958, covers approximately 207 sq. mi., about 70 mi. NW. of Ottawa (46°15'-46°30'N. 76°30'-76°45'W.). All consolidated rocks are crystalline and believed to be Precambrian. The Grenville series includes crystalline limestone interlayered with various kinds of paragneisses, quartzite, and pyroxene-rich rocks. Post-Grenville(?) rocks include granitic gneisses and injection gneiss which predominate in the area, small bodies of gabbro and associated basic and ultrabasic rocks occurring as conformable lenses within the various gneisses, and granite pegmatite and some syenitic rocks which intrude all the gneisses. Diabase dikes, considered the youngest rocks, occur here and there in the southwestern part of the region. Much of the area is mantled by glacial moraine, and exposures are sparse in places. Folds are complex and marked by drags, crenulations, and general undulations of the gneissic structure. In the southern and western part of the area and major structural trend is generally NW. and the dip is easterly at less than 45°. Towards the NE. the structural trend of the homocline changes from NW. to W. and the dip is N. Pyrite and a pyrite-graphite association were observed, also small magnetite occurrences. --A. C. Sangree.

1-1348. Remick, Jerome H. PRELIMINARY REPORT ON MARIN-PICQUET AREA, ABITIBI-EAST ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 361, 11 p., fold. geol. map (Prelim. Map no. 1219), scale 1:63,360, 1958, 6 refs.

The map-area comprises about 270 sq. mi. about 70 mi. SW. of Chibougamau (49°09'-49°30'N. 75° 30'-75°45'W.). Consolidated rocks are Precambrian, with about four-fifths of the area being underlain by biotite granite, in part gneissic. Bodies of hornblende schist, meta-anorthosite, hornblende diorite, and diabase also occur. Pleistocene glacial sediments, mostly silt, sand, gravel, and boulders, cover much of the area; eskers, drumlins, kettle lakes, sand plains, and ground moraine are the main depositional features. Schistosity, foliation, drag folds, faulting, and jointing are very briefly described. Small amounts of pyrite and chalcopyrite, hematite, and molybdenite were noted. --A. C. Sangree.

1-1349. Coats, Robert R. GEOLOGIC RECONNAISSANCE OF GARELOI ISLAND, ALEUTIAN

ISLANDS, ALASKA: U. S. Geol. Survey, Bull. 1028-J, p. 249-56, 3 illus. (1 in pocket), geol. map, scale 4 in. to 3 mi., May 1959, 6 refs.

Gareloi Island is the northernmost and Mount Gareloi is the only active volcano in the Delarof group, which is part of the western Aleutian Islands. It is a relatively simple composite active volcano 5,160 ft. high, and with minimum and maximum diameter of 5 and 6 mi., respectively. The volcanic activity on Gareloi Island occurred in 2 periods, separated by a long period of erosion and apparent volcanic quiescence. The younger rocks are substantially the same in composition as the older. The older rocks are a sequence of olivine basalt flows and scoria; the cone constructed of these rocks was deeply eroded and the ridges truncated by high sea cliffs. The younger lava flows are olivine basalt of variable texture, but generally porphyritic. Reports of activity date from 1760; the most violent eruption of which there is record occurred in 1929. The eruption was initially phreatic; a number of small craters were formed and from some of them glassy pumiceous andesite tuff was erupted, followed by blocky, highly viscous andesite lava flows. A small elongate fin of lava was extruded along the feeding fissure in one place. Small amounts of fumarolic material deposited along the fissure include atacamite, paratacamite, and hematite. Active emission of sulfur dioxide continues in the northern summit crater. --Auth.

1-1350. Fraser, George D., and H. Frank Barnett. GEOLOGY OF THE DELAROF AND WESTERNMOST ANDREANOF ISLANDS, ALEUTIAN ISLANDS, ALASKA: U. S. Geol. Survey, Bull. 1028-I, p. 211-48, 10 illus. (4 in pocket), 4 geol. maps (3 maps scale 1:25,000, 1 map scale 1:250,000), 2 tables, May 1959, 24 refs.

The layered rocks of the Delarof and westernmost Andreanof Islands are divisible into 5 units, generally younger from S. to N. Unit 1, the rocks of Amatignak Island, is composed of altered, well-bedded tuffaceous rocks including thick, finely banded, penecontemporaneously deformed argillite. These rocks apparently grade northward into unit 2, the altered pillow lavas and pyroclastic deposits of Ulak Island which are interpreted as a near-source facies of unit 1. The age of these 2 units is unknown but presumably is Tertiary. Unit 3 is a composite sequence of almost unaltered shallow marine and subaerial volcanic rocks composed of tuff-breccia, lava, pillow lava, and subordinate sedimentary rocks. This unit extends in a belt across the central Delarof Islands and the southern parts of Tanaga and Kanaga islands. Upper Tertiary fossils are found in the rocks on Tanaga and Kanaga; the rocks of the central Delarofs are correlated with these because of lithologic similarities. The rocks in unit 3 may be partly equivalent, extreme facies of the Amatignak rocks, or they may be younger. The contact is not exposed. Unit 4 is composed of Pleistocene precaldera lava that forms fragments of old shield volcanoes near the presently active cones. This lava, younger than most of unit 3, apparently intertongues in places with the upper part of the older sequence. Unit 5 comprises the composite cones of presently active Gareloi, Tanaga, and Kanaga volcanoes. All 5 bedrock units are andesitic to basaltic in composition.

Units 1, 2, and 3 are cut by many dikes, dike swarms, and sills of andesitic or basaltic composition. One limburgite intrusive mass and one light rhyodacite dike represent divergent compositions.

The older units are also cut by coarse-grained sills, dikes, and plutons, mostly of granodioritic composition. Ilak Island is part of a granodiorite pluton cut by aplite and andesite dikes; none of the invaded rock is exposed and the age is unknown.

None of the rocks have been regionally metamorphosed; even low-grade foliated rocks, such as slate and phyllite, are absent.

Submarine contours reveal a major trench and ridge structure for the Aleutian arc. Islands are actually peaks of a great arcuate mountain range. In this area the range rises 25,000 ft. from a foredeep on the Pacific side and 13,000 ft. from a deep on the N. The main ridge is apparently an arch bounded on the S. by a N.-dipping thrust zone and on the N. by a high-angle fault zone, downthrown to the N. Volcanoes are located along the inferred fault on the N. A group of transverse submarine and subaerial linear elements suggests further that the area has been segmented by high-angle faulting. An Aleutian island arc was probably formed in this general area as early as Miocene time, but the present volcanoes and the island locations and shapes were formed much later, probably in Pleistocene time.

Several stages of late Tertiary or Quaternary wave planation and subsequent differential tilting characterize the late history of the area; sporadic central-type volcanism at its N. edge began in early Pleistocene and has continued to the present time. Widespread deposition of Recent ash, and historic eruptions from Gareloi, Tanaga, and Kanaga volcanoes, are the most recent volcanic events. Glaciers were active on Tanaga and Amatignak during the Pleistocene, and ice patches are now present near dormant E. Tanaga volcanoes and on the high slopes of Gareloi Volcano. --Auth.

1-1351. Nelson, Willis H. GEOLOGY OF SEGULA, DAVIDOF AND KHVOSTOF ISLANDS, ALASKA: U. S. Geol. Survey, Bull. 1028-K, p. 257-66, 4 illus. (2 in pocket), 2 geol. maps, scale 1:25,000, May 1959, 2 refs.

Segula, Davidof, and Khvostof are volcanic islands [Rat Islands, western Aleutians; 51°57'-52°03'N. 178° 04'-178°31'E.] that rise from an extensive submarine platform about 350 ft. below sea level. The formation of this platform by erosion is the oldest geologic event recorded here. The subsequent history is largely a record of eruptions of andesitic lava and pyroclastic material which formed Segula Volcano and a hypothetical volcanic mountain immediately N. of Davidof Island. A catastrophic eruption, perhaps during late Tertiary time, destroyed this mountain, formed the caldera N. of Davidof Island and left Davidof and Khvostof islands as remnants. The most recently erupted lava and pyroclastic materials on Segula Island are young enough to have been virtually untouched by erosion. Deposits of reworked volcanic debris underlie small areas of these islands. --Auth.

1-1352. Moore, Raymond C., and Daniel F. Merriam. KANSAS FIELD CONFERENCE... 1959, 15-16 APRIL 1959: 55 p., illus., geol. maps, secs., [Lawrence, Kansas], State Geological Survey, University of Kansas, Apr. 1959, 28 refs.

The route of the 1959 field trip extends through Kansas for 225 mi. from Lawrence to Hutchinson, and was planned to emphasize Pennsylvanian and

Permian rocks exposed along the Kansas Turnpike. Background information for the trip includes generalized geologic maps and cross sections of the mid-continent region and Kansas. A detailed road log includes road maps, location of stops, points of interest, mileage, sketches of outcrops, and stratigraphic sections. Nine detailed measured sections include description of lithology, fossil content, thickness, and nomenclature. The Pleistocene sand and gravel "Equus beds" comprise a principal ground-water reservoir in Kansas. The Carey Salt Company of Hutchinson exploits salt beds of the Permian Wellington formation.

Current understanding of cyclic sedimentary deposits that comprise most of the Pennsylvanian and Lower Permian rock succession in Kansas and adjoining states includes 5 "accepted" conclusions and 6 conclusions and suggestions not generally accepted. The accepted conclusions are: 1) the actuality of cyclic sedimentary successions, 2) regional variations in nature of cyclothems, 3) widespread distribution of unit cyclothems, 4) generalized significance of cyclic "phases" in terms of paleoecology, and 5) the uniqueness of late Paleozoic cyclic sedimentation. The ideas not generally accepted concern: 1) boundaries of cyclothems, 2) contemporaneity of individual cyclothem "phases" within single provinces, 3) contemporaneity of individual cyclothems in widely separated regions, 4) a mechanism for transportation of clastic sediments, 5) the significance of knife-sharp lithologic boundaries and 6) the actuality of megacyclic successions.

Guidebook was prepared for distribution to field-trip participants only. -- M. Russell.

1-1353. McFarlan, Arthur C. BEHIND THE SCENERY IN KENTUCKY: Kentucky Geol. Survey, Spec. Pub. 10, Ser. 9, 144 p., illus., 1958.

This is a well-illustrated volume dealing with the development of the different geologic regions of the state and the many scenic features for which the state is well known. The subject matter is handled with picture and diagram as the main vehicle rather than text.

Kentucky has one of the truly fine state park systems of the country. This is due in part to the wise investment of funds, but nature endowed the state with a variety of striking natural features which cannot be matched in other states of the region. Kentucky has Natural Bridge, Cumberland Falls, and Carter Caves state parks, as well as Mammoth Cave and Cumberland Gap national parks. They are inspiring in their beauty and educational in their illustrations of how nature works. The purpose of this volume is to give the geological setting which is responsible for these attractions. They are the result of the same kind of geological changes being made today and are intimately tied in with the different kinds of rocks occurring in different parts of the state. --Kentucky Geol. Survey.

1-1354. Browne, Ruth, James Conkin, Barbara Conkin, and L. M. MacCary. GEOLOGICAL SOCIETY OF KENTUCKY FIELD TRIP, 1958: SEDIMENTATION AND STRATIGRAPHY OF SILURIAN AND DEVONIAN ROCKS IN THE LOUISVILLE AREA, KENTUCKY: Kentucky Geol. Survey 46 p., 14 figs., 1958, 15 refs.

The area covered by this field trip is in N.-central Kentucky and includes parts of Jefferson, Bullitt, and Oldham counties. Strata from Ordovician to Mississippian age are described at selected roadcuts and quarries; however, the trip is concerned primarily with Silurian and Devonian rocks. Deposition of the Silurian and Devonian is discussed in some detail--T. J. Crawford.

1-1355. Nosow, Edmund. GEOLOGICAL SOCIETY OF KENTUCKY FIELD TRIP, 1959: STRATIGRAPHY OF NELSON COUNTY AND ADJACENT AREAS: Kentucky Geol. Survey, 37 p., 15 figs., 1959, 14 refs.

This guidebook presents the stratigraphy of Nelson and adjoining counties through typical roadcut and quarry sections. A short discussion of the Green County, Kentucky, oil field is included. Oil is being produced in Green County from Silurian beds which are well exposed in Nelson County. --T. J. Crawford.

1-1356. Bain, George W., and others. GUIDEBOOK: GEOLOGY OF NORTHERN PART - CONNECTICUT VALLEY. 49th Meeting, New England Geological Conference: 56 p., 9 figs., 12 block diags., Amherst, Mass., Amherst College, Dept. of Geology, 1957.

This guidebook evolves history for the Connecticut Valley in Massachusetts and illustrates the regional development back through the Triassic period by means of a sequence of superimposable block diagrams. Tours to see critical exposures of the east wall structure, the Triassic stratigraphic section, the Triassic age volcanics, the glacial lake features, and the mineral occurrences are given in detail. Evidence from this area shows that most of the depression in the crystalline rock floor predated the Triassic fill and that almost all faulting ceased after volcanic quiescence. --Auth.

1-1357. Witkind, Irving J. QUATERNARY GEOLOGY OF THE SMOKE CREEK-MEDICINE LAKE-GRENORA AREA, MONTANA AND NORTH DAKOTA: U. S. Geol. Survey, Bull. 1073, 80 p., 29 illus. (4 in pocket), geol. map, scale 1:62,500, May 1959, 45 refs.

The Smoke Creek-Medicine Lake-Grenora area includes about 1,800 sq. mi. in northeastern Montana and northwestern North Dakota between the Canadian border and the Missouri River.

A long, shallow topographic trough that is now preserved as a dissected upland trends northeastward across the area. The floor of this trough descends from an altitude of about 2,102 ft. at the N. end to 1,912 ft. at the S. end where it joins the Missouri River valley. The ground rises E. and W. from the axial line of the trough. To the W. the ground surface consists of a relatively even till-surfaced upland with a maximum altitude of about 2,600 ft. The E. half of the area, at an altitude of about 2,100 ft. contains numerous undrained depressions, many of which are occupied by lakes, marshes, and swamps. In the southern part of the area the present valley floors have been cut well below the floor of the trough; this dissection is not so pronounced in the N.

The exposed rocks include the continental Fort Union formation of Paleocene age, the Flaxville gravel of Miocene or Pliocene age, and surficial deposits of Pleistocene age. The Fort Union formation underlies the entire area, although a complete section is nowhere exposed. The formation consists largely of light-colored siltstone, claystone,

and sandstone in which discontinuous beds of lignite occur. Where the lignite has burned, the overlying claystone and siltstone have been baked to a cherry-red clinker. In this area, which lies on the NW. flank of the Williston structural basin, the strata dip SE. at about 20 ft. to the mile. Little is known about the subsurface attitude of these and underlying beds. Fracturing may be indicated by a remarkably straight, 21-mi. -long northeastward-trending channel just north of Froid, Montana.

The Flaxville gravel, above the Fort Union formation, crops out along the W. edge of the area. Where observed within this area, it is 10 to 20 ft. thick, although a maximum thickness of 100 ft. has been given in other reports. The gravel consists of well-rounded pebbles of quartz, quartzite, and chert, all rust brown, in a matrix of fine sand. The average pebble is about 1 in. long.

The ancestral Missouri River is presumed to have traversed this area during late Tertiary and early Pleistocene time. If so, it flowed northeastward, and its course extended from near Poplar to a point near Grenora, North Dakota. For most of its length the projected course of the river is about 125 ft. above the upland.

Continental ice sheets probably overrode part of the area at least 3 times, and perhaps 4, during the Pleistocene. The resulting debris includes till and stratified sand and gravel. In places the bedded deposits lie on the till in the form of ice-contact features. Elsewhere, outwash sand and gravel fill broad channels that traverse the till-surfaced uplands. The thickness of fill in most of the channels is unknown; drill holes in the Big Muddy Creek valley have penetrated 185 ft. of drift above bedrock; this is probably close to the maximum thickness. Many of the pebbles in these deposits were derived from the Canadian Shield or adjacent to it; limestone and dolomite types predominate. The size ranges from fine sand to boulders 2 ft. in diameter. The average pebble diameter is about half an inch.

An exposure of well-indurated till(?), along Smoke Creek may represent deposits of a pre-Wisconsin ice sheet. On the basis of pebble counts, differences in topographic expression, and by extrapolation from adjacent areas, 3 till sheets have been mapped. Most of the western part of the area is covered by till that is considered to be of early Wisconsin(?) age. A small area in the eastern part, S. of Cottonwood Creek and W. of Little Muddy Creek, may be covered by till of middle Wisconsin(?) age. The greater part of the eastern half, however, is covered by till of Mankato age. Ice-contact deposits of early Wisconsin(?) and Mankato ages have been mapped.

The ice-contact deposits include eskers, kames, kame terraces, crevasse fillings, and small deposits of indefinite form. The materials are similar to those in the outwash, but they are not so well sorted.

Economic resources include deposits of lignite, glauber salt, sand and gravel, and glacial boulders suitable for riprap. The sodium sulfate deposits are confined to elongate shallow basinlike depressions within the glacial drift. The alignment of the deposits, many of which are linear, suggests some form of glacial control, probably ice-marginal channels now buried beneath till. Saline ground water moved through the buried channel outwash and broke through to the surface as springs in these till-surfaced depressions. In time, intermittent saline lakes were formed, confined in the basins by the impermeable till. Evaporation increased the salinity of the lakes, and eventually sodium sulfate was deposited. --Auth.

1-1358. Lovejoy, Donald W. OVERTHRUST ORDOVICIAN AND THE NANNIE'S PEAK INTRUSIVE, LONE MOUNTAIN, ELKO COUNTY, NEVADA: Geol. Soc. America, Bull., v. 70, no. 5, p. 539-64, 3 figs., fold geol. map and secs., scale 3 in. to 1 mi., 4 tables, May 1959, 29 refs.

The lower Paleozoic rocks of the Great Basin consist of an eastern facies, composed of carbonate rocks, in eastern Nevada and western Utah, and a western facies, composed of clastic rocks, cherts, and volcanic rocks, in central and western Nevada. Major thrust faults have moved the rocks of the western facies eastward over the rocks of the eastern facies.

The trace of one such thrust fault is exposed on the flanks of Lone Mountain in Elko County, Nevada. The rocks of the eastern facies lie beneath the thrust fault and are subdivided into the autochthonous McClellan Creek sequence and the allochthonous Coal Creek sequence. The McClellan Creek sequence is composed of Devonian(?) limestones; it is successively overthrust by the Devonian fractured limestone of the lower plate of the Coal Creek sequence and by the Upper Devonian limestones, shales, and calcareous siltstones of the upper plate of the Coal Creek sequence.

The rocks of the western facies lie above the thrust fault in a series of thrust slices. The name Basco formation is proposed for mappable lithic units in one of the thrust slices. The Basco formation is Ordovician and contains 4 members: (1) basal calcareous siltstone with a sandstone bed and lenses of altered peridotite, (2) lower chert, (3) shale, and (4) upper chert. About 1,750 ft. of the Basco formation is exposed within the thrust slice. The calcareous siltstone member of the Basco formation contains Early Ordovician graptolites, and the shale member contains Middle Ordovician graptolites. The Basco formation is overlain by Silurian siltstone.

The thrust fault at Lone Mountain is domed up by intrusive rocks of probable Miocene age. The most striking of these is the Nannie's Peak intrusive, which forms the crest of Lone Mountain; the intrusive is arcuate in map view, and it is interpreted to be a dike. Related stocks and dikes crop out on the E. flank of the mountain.

N., W., and S. of Lone Mountain, the Paleozoic rocks are overlain by Cenozoic conglomerate that grades upward into welded tuffs. Normal faulting may bound Lone Mountain along its eastern margin, and the desert valley to the E. is floored with vitric tuffs and with younger alluvium. The vitric tuffs are probably of late Miocene age, and they seem to grade laterally into the welded tuffs that lie N., W., and S. of Lone Mountain. --Auth.

1-1359. Stuckey, Jasper L., and Stephen G. Conrad. EXPLANATORY TEXT FOR GEOLOGIC MAP OF NORTH CAROLINA: North Carolina, Dept. Conserv. & Devel., Div. Mineral Resources, Bull. 71, 49 p., cross sec., 1958, 95 refs.

This bulletin contains a summary and description of the rock units and formations shown on the Geologic Map of North Carolina, scale 1:500,000, [see under Pt. 1. Geologic Maps]. It does not discuss geologic history, faulting, folding, unconformities or facies changes, and metamorphism is discussed only to the extent necessary in the description of the older rocks.

The rocks shown on the map are classed as sedimentary, metasedimentary, metavolcanic, and igneous and metamorphic, and range in age from Precambrian to Recent. Sedimentary rocks are most

abundant and underlie slightly less than half of the state. Igneous and metamorphic rocks are second in abundance and underlie approximately 30% of the state. Metavolcanic rocks underlie approximately 20% of the state, while metasedimentary rocks underlie only about 5% of the state.

The rocks of the state are divided into 54 units some of which are true stratigraphic formations, but the majority are classed as rock units. The sequence of these units in the explanation on the map represents as nearly as possible their true stratigraphic position in the earth's crust. These 54 formations and rock units are described in some detail, and limited information on the mineral resources they contain is given.--J. L. Stuckey.

1-1360. Dallas Geological Society, Dallas, Texas, and Ardmore Geological Society, Ardmore, Oklahoma. THE GEOLOGY OF THE OUACHITA MOUNTAINS - A SYMPOSIUM: 208 p., guidebook with 17 maps and cross sections under separate cover; pub. for 44th Ann. Meeting, American Association of Petroleum Geologists, and 33d Ann. Meeting, Society of Economic Paleontologists and Mineralogists, Dallas, Texas, March 16-19, 1959.

The Ouachita system includes an area of intermittently exposed Paleozoic rocks, 800 mi. long, from the Big Bend area of Texas, to Little Rock, Arkansas; and parallel belt buried beneath Mesozoic rocks of the Gulf Coastal Plain, 1,300 mi. long, from Chihuahua, Mexico, to southwestern Alabama.

This symposium presents the best assembly of facts and interpretations exant, on the perplexing and controversial problems of this interesting region. Papers are concerned with age and correlation of formations, rock facies and sedimentation, structure, mineralization, and the occurrence of hydrocarbons.

A picture emerges of a great mobile belt peripheral to, and S. of an old Paleozoic craton, with a history of progressive, intermittent, northward migration of the geosyncline to a late Paleozoic site near the location of the present exposures of the thick Stanley-Atoka sequence.

The late Charles E. Decker, in a manuscript submitted Aug. 16, 1958, one week before his death, provided a set of lower Paleozoic correlations based largely on graptolites. The oldest fossiliferous strata in the Ouachita Mountains--Mazarn shale--are of Lower Ordovician age, correlated with the upper part of the Arbuckle group. Correlations of Middle and Upper Ordovician, Silurian, and Devonian units are fairly definite. Decker assigned the unfossiliferous Crystal Mountain sandstone, Collier shale, and Lukfata sandstone to the Upper Cambrian; others variously regard these as of Lower or Middle Ordovician age.

A black shale in the lower part of the Johns Valley formation has lithology and fossils similar to the Caney shale of the Arbuckle Mountains. Significant new information and interpretations by Harlton, Elias, and Cline and Shelburne affirm this as a valid correlation, and indicate the Mississippian age of at least the lower part of the Johns Valley and the underlying Jackfork and Stanley. The exotic boulders are shown to be of sedimentary rather than tectonic origin.

Whatever detailed correlations are ultimately made for the Stanley, Jackfork, and Johns Valley must include a break with uplift and erosion somewhere in the region, of sufficient magnitude to have exposed Arbuckle-Ozark facies rocks as old as Lower Ordovician, in order to provide a source for the erratics in the Upper Jackfork and Johns Valley formations.

Lower Pennsylvanian age of the upper part of the Johns Valley is established. The overlying sandstones and shales have been classified as Atokan. On the basis of extensive post-Morrowan uplift and erosion throughout adjoining areas, Branson suggests that the "Atoka" of the Ouachitas should be considered as Morrowan. This view is supported, in part, by Laudon, who shows a uniform thickening of the Morrowan southward across the McAlester basin to 850 ft. just N. of the Choctaw fault; the contrast with only 300 ft. of rocks assigned to the Morrowan in the frontal Ouachitas leads him to wonder whether part of the lower "Atoka" is not of Morrowan age. Scull, Glover, and Planalp raise the same question in a paper concerning the Atoka of the McAlester basin-Arkansas Valley area. Cline and Shelburne, on the basis of lithologic similarity of sandstones of Johns Valley and lower "Atoka" and the lack of unconformity in the central Ouachitas, conclude that the base of the "Atoka" is of Morrowan age.

The marked lithologic contrast between units of equivalent age in the Arbuckle and Ouachita Mountains is most apparent in rocks representing the pre-Upper Ordovician, Devonian, and Mississippian. The differences are attributed to deposition in separate geosynclines. Ham concludes from the thicker section in the Arbuckle province that the term "Ouachita geosyncline" should not be applied to lower Paleozoic rocks, but should be restricted to Stanley, Jackfork, and Atoka sediments.

Flawn and Goldstein, on evidence from wells drilled beneath the Mesozoic of the Gulf Coastal Plain, suggest that the true axial sediments of the lower Paleozoic were deposited in a geosyncline to the S. of the Marathon-Ouachita belt. This early Paleozoic geosyncline received a great load of sediments of which the pre-Stanley rocks exposed in the Ouachita Mountains were merely the foreland edges.

A great gravity minimum underlies the Ouachita Mountains, portraying a deep sedimentary basin, which Howell and Lyons attribute to a great downfolding of the earth's crust into the mantle. Miser attributes the gravity minimum to thick Mississippian and Pennsylvanian rocks and to piling-up in overthrust sheets. Tomlinson suggests a deeply buried basement overlain by a thick Cambrian section, and believes the great negative anomaly argues against the idea that the exposed rocks in this region constitute an imported thrust plate.

Flawn's subsurface evidence shows that in places in Texas, Ouachita facies rocks--Stanley and pre-Stanley--have been thrust over rocks of the foreland facies; and a similar situation is inferred in SE. Mississippi and SW. Alabama, where highly sheared metasedimentary rocks have been thrust over Pennsylvanian and Ordovician of the southwestern margin of the Black Warrior basin. Buried beneath the Mesozoic rocks on the Gulf Coastal Plain there are 3 zones which, from NW. to SE., Flawn differentiates on the basis of metamorphism: (1) a frontal zone of unmetamorphosed folded and thrust faulted rocks, (2) a zone of incipiently to very weakly metamorphosed rocks, and (3) a zone of highly sheared, low-grade metamorphosed rocks thrust westward over zones (2) and (1). The contact is called the Luling overthrust fault. Flawn compared zone (1) with the Valley and Ridge province of the Appalachians, the Luling overthrust with the Blue Ridge front, and zones (2) and (3) with the Blue Ridge province. The foundation of the coastal plain of Texas and Louisiana

may be a deeply buried counterpart of the Piedmont.

The importance of thrusting in the orogeny of the Ouachita Mountains proper, presents an interesting controversy. Tomlinson believes the evidence heretofore advanced to support the hypothesis of extensive low-angle thrusting is either unconvincing or inapplicable. Particularly, he and Pitt deny the existence of windows in the core area near Broken Bow and in the Potato Hills. Rather, Tomlinson thinks thrusts are minor, and the product of close compression of a geosyncline in situ; he involkes T. C. Chamberlian's "Wedge Theory of Diastrophism" as best explaining Ouachita structure.

Miser reaffirms his adherence to the thrusting hypothesis--including the existence of windows near Broken Bow and in the Potato Hills. Hendricks presents evidence from the frontal belt of the Ouachitas to show that the angle of dip of some faults is as low as 20°, and that 53 mi. of cumulative WNW. movement of fault plates between the Jackfork Creek and Choctaw faults can be demonstrated.

Sulfides of Mg, Sb, Pb, Zn, and Cu; oxides of Mn and Ti; and diamonds, barite, and quartz comprise the economic mineral suite of the Ouachita province. In only a few of the mineral deposits are ore minerals found in commercial quantity. Scull states that barite is the common denominator in all mineral deposits except quartz crystals, and the replacement barite deposits are chemically and genetically related to the Magnet Cove igneous complex, and are therefore of the same age as the igneous suite. Emplacement is dated as post-Trinity, pre-Brownstown, or early upper Cretaceous. Miser relates the mineralization--metalliferous as well as quartz veins--to the closing stages of Pennsylvanian orogeny, and to the belt of metamorphosed rocks in the Broken Bow-Benton uplift.

Hydrocarbons in the form of grahamite and asphalt are widespread in the Ouachita Mountains; there are some seepages of unaltered crude oil similar in quality to crude from oil fields in the Arbuckle area. Oil and gas have been found in small quantities by drilling. Howell and Lyons believe the evidence justifies the hope of finding oil and gas in commercial quantities under favorable conditions. These conditions are stated to be: relatively undisturbed beds folded instead of faulted, at moderate depths beneath the highly disturbed surface beds. --R. H. Dott.

1-1361. Dort, Wakefield, Jr. PRELIMINARY GEOLOGIC MAP OF PART OF ALLENSVILLE QUADRANGLE, PENNSYLVANIA: Compass, v. 36, no. 4, p. 336-38, index map, geol. map, May 1959.

Map shows the surface distribution of 9 Silurian and 8 Devonian formations. The major structure indicated is a broad asymmetric syncline. The map is located, by means of index maps, to Altoona, Pine Grove Mills, and McAlevys Fort, but otherwise lacks base detail. Scale is approximately 2 mi. to 1 in. --M. Russell.

1-1362. Ordway, Richard J. GEOLOGY OF THE BUFFALO MOUNTAIN-CHEROKEE MOUNTAIN AREA, NORTHEASTERN TENNESSEE: Geol. Soc. America, Bull., v. 70, no. 5, p. 619-35, 3 figs., fold. map and sec., scale 1 in. to 2,000 ft., 2 tables, May 1959, 15 refs.

The Buffalo Mountain-Cherokee Mountain area in northeastern Tennessee includes about 45 sq. mi. and is located along the SE. border of the Appalachian Valley and Ridge geomorphic province. The mountainous part of the area is underlain almost entirely by the Buffalo Mountain thrust sheet, which has been separated by 2 minor thrust faults into 3 imbricate thrust blocks.

Cambrian and Precambrian(?) rocks in the Buffalo Mountain thrust sheet consist of the Unicoi, Hampton, and Erwin formations (Chilhowee group) and the Shady dolomite. Younger Cambrian-Ordovician rocks beneath the thrust sheet include the Honaker limestone, Nolichucky shale, Knox dolomite, and Athens shale.

During or following the thrusting, all the rocks in the area were folded into a synclinorium trending NE.-SW. Some folding apparently preceded the thrusting. Several "shear faults" mapped by Keith in this area do not appear to exist. An interesting feature of the structure is the number of slices that have been broken off and dragged along the thrust surfaces. Slices of younger rocks have been found between older rocks, and slices of older rocks between younger. Cleavage and a low-rank metamorphism are present. Deformation probably occurred in late Paleozoic time during the Appalachian orogeny. --Auth.

1-1363. South Texas Geological Society. 1958 FALL FIELD TRIP, DECEMBER 5, 1958, EOCENE - MIOCENE, OIL - URANIUM: FALLS CITY, TORDILLA HILL & FASHING AREAS, WILSON, KARNES & ATASCOSA COUNTIES, TEXAS: 67 p., 3 illus. (1 in pocket), 13 maps (1 in pocket), 5 secs., log, San Antonio, Texas, 1958, refs.

A road log by Robert Pavlovic, George R. Pinkley and E. J. Matulich includes maps and cross sections of surface outcrops from Floresville to Campbellton, Texas.

Paul C. de Vergie of the Atomic Energy Commission describes the detailed stratigraphy and structure of the recent uranium discoveries in the Tordilla Hills Area. Illustrations include several topographic maps and cross sections in Karnes County, Texas.

George R. Pinkley contributes a comprehensive report of the recently drilled 11,000-ft. Fashing Field in Atascosa County with a subsurface map of the area.

A subsurface study of the Oakville Field, Live Oak County, by Thomas S. West, Sr., of San Antonio is an extra report in this guidebook that was not covered on the field trip. --F. F. Edwards.

1-1364. Hill, Patrick Arthur. GUAOS AREA, LAS VILLAS, CUBA: Carleton Univ., Dept. Geology, Geol. Paper 58-1, 8 p., geol. map (fold. in envelope), scale 1:84,500, sec. and magnetic profiles on map sheet, 1958, 10 refs.

Ten geologic units are described, ranging from Mesozoic(?) to Upper Cretaceous. A band of amphibolite separates granodiorite from the limestones and schists of the Trinidad mountains and is traceable for at least 40 km. Available evidence suggests that the mountain massif is autochthonous. --Auth.

1-1365. Eckel, Edwin B. GEOLOGY AND MINERAL RESOURCES OF PARAGUAY - A RECONNAISSANCE. With a section on igneous and metamorphic rocks by Charles Milton and Edwin B. Eckel, and a section on soils by Pedro Tirado Sulsona: U. S. Geol. Survey, Prof. Paper 327, 110 p., 61 illus. (2 in pocket); geol. map scale 1:1,000,000, soil map scale 1 in. to 32 mi., 6 tables, May 1959, 96 refs.

Although this report includes the results of a 6-month reconnaissance investigation of the geology and mineral resources of Paraguay, it is essentially a compilation and interpretation of existing published and unpublished information on the subject.

The rocks can be divided into 5 major classes, depending on age and mode of origin. The oldest are of Precambrian age, here subdivided into an older group of metamorphic rocks and a younger group of granitic rocks. They are a part of the Brazilian shield and underlie the entire country but are exposed at the surface in only a few places. The second group consists of marine sedimentary rocks and ranges in age from Cambrian or Ordovician through Early Devonian. It comprises 3 mappable units, here called the Itapucumí series, the Caacupé series and the Itacurubí series. The third group, which ranges from Pennsylvanian through Triassic in age, constitutes the Gondwana or Santa Catarina continental clastic sedimentary rocks known in a large part of South America. This group is divisible into 3 map units - the Tubarão series of glacial deposits, the Independencia series, and the Misiones sandstone - and, like the marine beds of Paleozoic age, is much thinner in eastern Paraguay than it is in parts of the Gran Chaco in the western half of the country. The fourth group is Tertiary to Recent in age and consists in large part of unconsolidated clay and sand of continental origin. These materials are very thin in most of eastern Paraguay, but they cover nearly all of the Gran Chaco to depths as great as 2,000 ft.

The fifth large group of rocks consists of igneous extrusive and intrusive rocks, mostly of basic composition. The most important single member is the Serra Geral basaltic lava, of Late Triassic or Jurassic age, which covers the eastern edge of the country and extends far into Brazil. Associated with the Serra Geral lavas are many smaller bodies of intrusive diabase, extrusive basalt, and possibly other rocks. There are also many intrusive and extrusive igneous rocks whose age is unknown. Some are strongly alkalic and of considerable interest petrographically; some may be related in age and origin to the Serra Geral lavas, but for others there is strong evidence that they are no older than late Tertiary. Chemical and spectrographic analyses of a number of samples of the igneous rocks are included in the report.

The geologic structure of Paraguay appears to be relatively simple in its grosser aspects, but little is known of even the larger features. In the eastern half of the country the beds dip gently eastward toward the great Paraná basin of southeastern Brazil. This easterly dip appears to reverse along the axis of a low anticline that trends N.-S. only a few kilometers E. of the Río Paraguay and exposes the older sediments and the Precambrian basement rocks at the surface in many places. W. of this axis the beds either dip steeply westward, or are downfaulted to the W., into the depths of the Gran Chaco basin. The rocks in this basin are, in places, at least 10,000 ft. deeper than they are in eastern Paraguay; W. of the basin, in eastern Bolivia, they rise to the surface in a series of anticlines and synclines that form the foothills of the Andes.

Paraguay possesses large quantities of certain nonmetallic mineral resources, notably clays for brick, tile, and pottery; limestone and other raw materials for portland cement and for lime; common and ornamental building stones; glass sand; talc; and mineral pigments. Except for Fe ore, of which there are many small but rich deposits, Paraguay appears to be poorly endowed in most other mineral resources. It has a little Mn, Cu, mica, and beryl, and there are good geologic reasons for hoping that worthwhile deposits of salt, gypsum, and bauxite may yet be discovered.

Aside from wood, and water power that is both remote and undeveloped, the only known source of fuel or energy lies in some little-known peat deposits near Pilar. Petroleum may exist in the Gran Chaco basin, but proof of its presence must await a willingness on the part of Paraguayan or other investors to risk much more money than has already been spent in one exploratory campaign.

Besides the available facts on all of the country's known and reported mineral resources, a number of suggestions are given for establishing local industries that could provide mineral products for local use and conserve some of Paraguay's foreign exchange. By all odds the most valuable and promising of Paraguay's mineral resources are the water resources, both surface and underground, and the soils. --Auth.

2. GEOMORPHOLOGY

See also: Geologic Maps 1-1320 through 1-1323; Areal and Regional Geology 1-1353, 1-1357; Stratigraphy 1-1406; Mineralogy 1-1483, 1-1484; Geohydrology 1-1525.

1-1366. Ogden, J. Gordon, III. A LATE-GLACIAL POLLEN SEQUENCE FROM MARTHA'S VINEYARD, MASSACHUSETTS: Am. Jour. Sci., v. 257, no. 5, p. 366-81, 3 figs. incl. 2 maps, 2 pls. (fold.), May 1959, 31 refs.

The Wisconsin post-glaciation climatic and vegetational changes of New England have been established in northern Maine, central Massachusetts, and southern New England by pollen-stratigraphic studies. Correlation of equivalent pollen horizons provides an internally consistent history of the climate and vegetation since deglaciation. Radiocarbon dates from specific horizons permit the correlation of the regional chronology with the glacial sequence in other parts of North America and Europe.

Pollen analysis of a late-glacial sediment core from the island of Martha's Vineyard, Massachusetts, includes the 2 major cold periods (corresponding to the Valders and Port Huron ice readvances in the Great Lakes region) recognized from other New England pollen diagrams. In addition, a third, older, cold period is recognized on Martha's Vineyard. This cold time is correlated with the emplacement of the Buzzards Bay moraine 5 mi. to the N. of the core site. The pollen record during the period of ice advance that built the Buzzards Bay moraine shows an absolute minimum of total tree pollen (as low as 10%) and indicates the presence of a number of high-arctic plants, at least one of which (Armeria sibirica, Turcz.) is apparently restricted to true arctic tundra today.

A change in the size-frequency distribution of pine pollen suggests that white and red pine pollen types replaced jack pine pollen types on Martha's Vineyard approximately 1000 years before a similar change was recorded in central Massachusetts. --Auth.

1-1367. Wood, Roger L. ICE-PUSH DEFORMATION IN SHAWNEE COUNTY, KANSAS: Compass, v. 36, no. 4, p. 304-309, 2 illus., sec., May 1959, 6 refs.

The structure described differs from any ice-push deformation previously cited. Fractured, boulderlike blocks of limestone rest unconformably on beds which are stratigraphically 40 ft. lower. Preglacial topographic control coupled with the pressure of an advancing glacial lobe are proposed to explain the origin of this unusual feature. --Auth.

1-1368. Fobes, Charles B. GLACIAL POTHOLES ON RUMFORD WHITECAP MOUNTAIN: Maine Field Naturalist, v. 13, no. 1-2, p. 2-7, 3 illus., Jan.-Apr. 1957, 11 refs.

Two glacial potholes, the highest yet found in Maine (2,100 ft. above sea level) are described. A brief discussion on their possible origin and a short review of other potholes found in Maine are given.--Auth.

1-1369. Budel, Julius. THE "PERIGLACIAL" - MORPHOLOGIC EFFECTS OF THE PLEISTOCENE CLIMATE OVER THE ENTIRE WORLD. Translated by H. E. Wright and David Alt: Internat. Geology Rev., v. 1, no. 3, p. 1-16, 4 figs., March 1959, 25 refs.

Differing climates result in differing landforms. The colder and drier climate in nontropic regions and the moderately cooler and more humid climate in the tropics during the Würm glacial period resulted in different morphogenetic processes and landforms than those forming today. All morphological effects of the Ice Age originated from the ultimate causal effect of Pleistocene variations such as temperature, means and ranges, moisture relationships, secondary influences of glaciers, etc.

An analysis of the Würm indicates ways in which its climate has influenced the present central European landscape, an area outside the glaciated area during the Ice Age. The climatic-morphologic processes associated with the more oceanic climate of the first portion of the Würm cold phase, as indicated by relic forms of oceanic frost-rubble tundra zone in western and central Europe, still dominate most of the basin areas of central western Europe where their traces were covered in a second, drier portion by continental loess tundra. Three main phases (cold-oceanic solifluction, loess, and later rewarming) of the Würm influenced central and southeastern Europe. --G. E. Denegar.

1-1370. Lessig, Heber D. BURIED SOILS OF GLOBE HILL, UPPER OHIO VALLEY: Ohio Jour. Sci., v. 59, no. 1, p. 48-54, 2 figs., Jan. 1959, 5 refs.

Globe Hill is a remnant of a terrace, at 820-900 ft. elevation, on the West Virginia side of the Ohio Valley about 5 mi. S. of Wellsville, Ohio.

Detailed study of an excavation for a new highway at Globe Hill reveals 3 buried paleosols of varying ages beneath a modern soil formed from a thin layer of colluvium and a deeply leached loess. The soil of the loess is developed to a degree similar to soils developed from medium-textured Illinoian drift about 15 mi. to the N. The high level, 1000 ft., glacial outwash terrace of the upper Ohio Valley occurs 900 ft. E. of Globe Hill and about 100 ft. higher. Thus, the author believes that the buried paleosols were formed during pre-Illinoian stages and substages of the Pleistocene and later than the stage of the first glaciation of the Allegheny Plateau. --Auth.

1-1371. Lessig, Heber D. SOIL AND PALEOSOL OF THE WARNOCK TERRACE: Ohio Jour. Sci., v. 59, no. 2, p. 76-80, 2 figs., March 1959, 4 refs.

Soils developed on high level terrace remnants at the 960 to 1020 ft. level are being studied at several places in the upper Ohio drainage basin with a view of determining some of the early Pleistocene history of the region. A tributary terrace of the Ohio Valley, near Warnock, Belmont County, Ohio, has a modern moderately well-drained soil formed over a paleo-humic-gley soil. While both soils are formed from alluvium from weathering of local rocks, the modern soil is correlated with the high level glacial outwash terrace of the Ohio Valley because its material was deposited during the ponding of preglacial, northward drainage by the first glaciation of the Allegheny Plateau. The buried paleo-humic-gley soil is presumedly the soil of the preglacial Teays age terrace which was buried during this ponding. --Auth.

1-1372. Wiens, Herold J. ATOLL DEVELOPMENT AND MORPHOLOGY: Assoc. Am. Geographers, Annals, v. 49, no. 1, p. 31-54, 15 illus., chart, diag., March 1959, 78 refs.

An atoll is a more or less continuous reef, forming an enclosure around a lagoon having no emerged volcanic islands. Deep drilling has revealed that atolls consist of several thousand feet of shallow-water limestones as old as Oligocene and possibly Eocene. Either uniform subsidence of the ocean floor or rise in sea level, at a rate not to exceed reef growth or about 2 m. per 100 years, can explain atoll development. Fossils from guyots indicate such relative movement since the Cretaceous. The antecedent-platform theory is inadequate for most atolls. Pleistocene sea-level changes influenced atoll development. Uniform subsidence with Pleistocene sea-level fluctuation is the primary set of factors governing atoll development. Erosion by mechanical, biochemical, and bio-mechanical means, and solution by sea water are all important in present-day atoll morphology. Surge channels are destructional features. Beach rock formation takes place within a matter of months, but the process is not well understood. Islands may have resulted from remnants of reef during higher sea level periods, but severe storms are known to pile debris well above sea level where a fresh-water lens can form and land vegetation take root. The immediate geologic future of atoll islands depends on whether sea level rises or falls, currently a matter of dispute. --M. Russell.

1-1373. Jordan, G. F., and H. B. Stewart, Jr. CONTINENTAL SLOPE OFF SOUTHWEST FLORIDA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 974-91, 11 figs. incl. 2 charts, profiles, May 1959, 19 refs.

Recent surveys of the W. Florida continental slope made by the U. S. Coast and Geodetic Survey show for the first time the detailed topography of the southern part of this area. A marked change in topography at 27° N. separates the northern from the southern part of the slope and is related to N.-to-S. changes

from clastic to nonclastic underlying bedrock and from thick to thin or nonexistent overburden of unconsolidated sediments.

A drowned barrier spit and lagoon unchanged by subsequent erosion or deposition were revealed at 75-100 fathoms. These features are described and discussed along with numerous long breaks in slope, embayments, and offsets in the steep lower slope, reef patches, domelike structures, and spur-shaped ridges. --Auth.

1-1374. Spetzman, Lloyd A. VEGETATION OF THE ARCTIC SLOPE OF ALASKA: U. S. Geol. Survey, Prof. Paper 302-B, p. 19-58, 11 illus., 3 tables, May 1959, 26 refs.

The environment of the Arctic Slope is described by physiographic provinces, namely, the coastal plain, foothills, and mountains. Topography, rock composition, soil, vegetation, and climate are considered for each province.

Six major plant communities, which together compose the tundra of the Arctic Slope, are described. These are the niggerhead meadows, wet sedge meadows, dry upland meadows, flood-plain and cut-bank vegetation, outcrop and talus vegetation, and aquatic vegetation of lakes. The dominant and secondary plants in each community are given, as well as local variations in the vegetation which are related to minor habitat differences such as slope exposure or bedrock.

Lines of successional change, primarily for the vegetation in the foothills, are suggested.

Seven localities, representing the common habitats of vegetation occurring on the Arctic Slope, are described to illustrate natural mosaics of plant communities.

Included is a list of 439 species of higher plants which grow on the Arctic Slope, together with their distribution, altitude range, abundance, flowering period, and habitat. This list is based on about 4,500 collections of plants made from 1945 through 1951, supplemented by information of previous collections which is compiled in Hulten's flora of Alaska. --Auth.

3. STRUCTURAL GEOLOGY

See also: Geologic Maps 1-1328 through 1-1334; Areal and Regional Geology 1-1358, 1-1362; Stratigraphy 1-1411, 1-1412; Geophysics 1-1445; Fuels 1-1556, 1-1559, 1-1560, 1-1564, 1-1566.

1-1375. Wheeler, Robert R. TENSIONAL CONCEPT OF RIFTING: Geol. Soc. America, Bull., v. 70, no. 5, p. 667-68, 2 figs., May 1959, 2 refs.

An analysis of the Dead Sea graben favors the hypothesis that rift valleys are the result of tensional stresses accompanied by gravitational downdropping of the graben rather than a forcing down by compressional forces and reverse faulting. Negative anomalies may not demonstrate buoyancy relations. The tensional aspects may be more recent adjustments to pre-Tertiary compression and possibly large-scale horizontal displacements. --M. Russell.

1-1376. Lill, Gordon G., and Arthur E. Maxwell. THE EARTH'S MANTLE: Science, v. 129, no. 3360, 1407-1410, graph, May 22, 1959, 14 refs.

The prospect of drilling to and through the Mohorovičić discontinuity, long a dream of scientists, now is a practical, though expensive, possibility. Prodded by a semi-social, semi-scientific group called the American Miscellaneous Society, scientists are making plans to drill, as factors permit, in an oceanic basin where the "Moho" is at a least depth below the earth's crust. Suggested sites are near Puerto Rico and in the Pacific Ocean. At least 5 million dollars appears necessary to design, build, and run the project which would be well worth the cost if the resulting record reveals needed information on the sedimentary layers of the ocean floor and the nature of the earth's mantle.--M. Russell.

1-1377. Chamberlain, J. A. STRUCTURAL HISTORY OF THE BEAVERLODGE AREA: Econ. Geology, v. 54, no. 3, p. 478-94, 6 figs. incl. 3 maps, diags., sec., table, May 1959, 15 refs.

The Precambrian rocks of the Beaverlodge area, northern Saskatchewan, are divisible into 2 broad units, (1) the highly folded and extensively granitized Tazin group unconformably overlain by (2), the synclinally folded Athabasca series. These rocks are cut by 3 major faults, and evidence is presented to show that 2 of these, the St. Louis and ABC faults, are probably extensions of the same break despite a bend of 80° between the 2 prolongations. Age of faulting is discussed and it is concluded that much, if not all, of the fault movements occurred in post-Athabascan time. A method is described by which quantitative estimates of the net-slip on the St. Louis-ABC fault are calculated. Movement is normal, the net-slip roughly 4 mi. A minimum normal dip-slip component of movement on the Black Bay fault is found to be of the same order of magnitude. A 4-stage tectonic history of the area is presented in which 2 periods of crustal shortening alternate with regional, then localized epeirogenic movements. Wherever possible, idealized block diagrams are used to illustrate tectonic events. A table summarizes the tectonic history of the area. --Auth.

1-1378. Merriam, Daniel F. STRUCTURE OF KANSAS AS SHOWN ON TOP OF THE LANSING GROUP (PENNSYLVANIAN): Compass, v. 36, no. 4, p. 257-63, index map, struct. map, May 1959, 7 refs.

A preliminary regional structural map of Kansas contoured on the Lansing group (Missourian, Pennsylvanian) on a 100-ft. interval is presented along with a brief discussion of pertinent structures revealed on the map. Several major structures in the state including the Prairie Plains homocline, Brownville syncline, Nemaha anticline, Salina basin, Sedgwick basin, Cambridge arch, central Kansas uplift, Geneseo uplift, Pratt anticline, Hugoton embayment of the Anadarko basin, and Keyes dome are discernable on the Lansing as well as numerous other minor anticlinal and basinal structures. --Auth.

1-1379. Rod, Emile. WEST END OF SERRANIA DEL INTERIOR, EASTERN VENEZUELA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 772-89, 9 figs. incl. 5 maps, sec., Apr. 1959, 18 refs.

None of the structural elements of the Serranía del Interior of the Eastern Caribbean Mountains continues toward the W. Near the W. end of the Serranía the fold axes are dragged and cut off by the right-lateral Urica strike-slip fault. Folding in the 2 fault blocks was independent. The relative cumulative displacement of the Urica fault is maximum (possibly 40 km. or more) at its northwestern end S. of Barcelona and gradually diminishes from this point SE. In the Tacat area the Urica fault turns sharply in an easterly direction and goes over into the Pirital thrust where the horizontal component is finally taken up by the thrust movement.--Auth.

1-1380. Rengarten, P. A. HERCYNIAN STRUCTURAL-FACIES ZONES OF THE EASTERN BALKHASH REGION. Translated by L. Drashevska: Internat. Geology Rev., v. 1, no. 3, p. 39-49, map, diag., table, March 1959, 7 refs.

Three zones, the northern or Tarbagatay, the central or Bakanass, and the southern or Balkhash, have been distinguished in the eastern Balkhash region, U. S. S. R., on the basis of their geologic development during Hercynian time. These zones are separated by great, regional, probably deep-seated, fractures. They are characterized by specific conditions under which sediments accumulated, certain thickness values, evidence of magmatic activity, and mineral concentrations. Each zone is also differentiated by a particular type of magnetic field. The Tarbagatay and Balkhash zones developed under geanticlinal conditions; the Bakanass zone was the product of a geosynclinal environment. --G. E. Denegar.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 1-1352, 1-1354, 1-1355, 1-1356, 1-1358; Geomorphology 1-1366; Paleontology 1-1429; Sedimentary Petrology 1-1506, 1-1509; Geohydrology 1-1533; Engineering Geology 1-1575.

1-1381. Bogdanov, N. A. THE OUTLINES OF STRATIGRAPHY OF PRECAMBRIAN ROCKS IN THE DZHAGDA AND TUKURINGER MOUNTAIN RANGES. Translated by Salih Faizi: Internat. Geology Rev., v. 1, no. 3, p. 34-38, table, March 1959, 11 refs.

The Precambrian formations outcropping along the Tukuringer and Dzhagda ranges, U. S. S. R. (50°-55°N. 120°-135°E.), consist of the Archean Ust-Gilui gneisses and schists intruded by granite-gneisses, pegmatites, and aplites; lower and middle Proterozoic Chala quartzitelike sandstones and schists, Algai schists and quartzites, and Dzhugdagin schists and limestones; and upper Proterozoic Unya-Boma sandstones, sandy shales, phyllites, porphyries, and limestones. The Proterozoic section here is apparently one of the most complete Precambrian sections in the southern part of the Soviet Far East. --G. E. Denegar.

1-1382. Lippitt, L. STATISTICAL ANALYSIS OF REGIONAL FACIES CHANGE IN ORDOVICIAN COBOURG LIMESTONE IN NORTHWESTERN NEW YORK AND SOUTHERN ONTARIO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 807-816, 5 figs. incl. map, 3 tables, Apr. 1959, 9 refs.

Multiple regression analysis is applied to the study of facies change in the Ordovician lower Cobourg limestone in northwestern New York and southern Ontario. A linear surface is fitted to the scattered outcrop data. The results indicate an increase in the lower Cobourg calcilutites north-northeastward along the outcrop E. and N. of Lake Ontario and an accompanying decrease in the calcarenite texture. This is interpreted as a winnowing-out of the calcareous muds into the deeper water on the NNE.

Preferred orientation of lower Cobourg pararipples indicates that NE.-SW. currents predominated. Progressive change in mean pararipple wavelength tends to support the northward increase in depth of water obtained from the texture analysis.

A synthesis of the linear regression results for Shoreham, early Denmark, and lower Cobourg textural data in the northwestern New York area denotes maximum submergence in early Shoreham and minimum submergence around early Denmark. Lower Cobourg seas were slightly deeper than early Denmark.--Auth.

1-1383. Oxley, Philip, and Marshall Kay. ORDOVICIAN CHAZYAN SERIES OF CHAMPLAIN VALLEY, NEW YORK AND VERMONT, AND ITS REEFS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 817-53, 10 figs. incl. illus., 6 maps, diag., 2 tables, Apr. 1959, 36 refs.

The Ordovician Chazyan series succeeds the Canadian series and underlies the Blackriveran series. In the type region of the Champlain Valley the series is separable into the Dayan, Crownian, and Valcourian stages, distinguished by faunal criteria. Thickness approaches 1,000 ft. as a maximum, diminishing by overlap, offlap, and convergence. Local variations are so great and outcrops so distributed that regional isopach maps are only suggestive. Each stage has several lithologic facies. Reefs are prevalent in sections having minimum thickness, contrasting with argillaceous calcisiltstones of the thicker sections. The reef-building organisms include some of the earliest corals and bryozoans, as well as sponges and stromatolites. The reef belt lay between lowlands of the continental interior and deeper water of western New England. --Auth.

1-1384. Wells, Francis G., George W. Walker, and Charles W. Merriam. UPPER ORDOVICIAN(?) AND UPPER SILURIAN FORMATIONS OF THE NORTHERN KLAMATH MOUNTAINS, CALIFORNIA: Geol. Soc. America, Bull., v. 70, no. 5, p. 645-50, fig., fold. geol. map, scale 1 in. to 5 mi., May 1959.

Upper Ordovician(?) phyllite and Upper Silurian sedimentary rocks are brought to the surface in broad northeasterly trending folds between Shasta and Scott valleys, Siskiyou County, California. These rocks are here named the Duzel formation and the Gazelle formation respectively. --Auth. introd.

1-1385. Edie, Ralph W. MIDDLE DEVONIAN SEDIMENTATION AND OIL POSSIBILITIES, CENTRAL SASKATCHEWAN, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 1026-1057, 10 figs. incl. 5 maps, secs., pl., May 1959, 60 refs.

The stratigraphic interval discussed in this paper includes the Elk Point group and Dawson Bay formation of Middle Devonian age. The Elk Point group (60-800 ft. thick) comprising in ascending order the Ashern, Winnipegosis, and Prairie Evaporite formations is overlain by the Dawson Bay formation (100-200 ft. thick).

The Ashern consists of 20-50 ft. of brick red shale or claystone resting unconformably on the Silurian Interlake group. The Winnipegosis includes reef and off-reef deposits. The off-reef material (approximately 40 ft. thick) consists of cream to brown secondary dolomite (locally limestone) with black shale partings. The reef material has maximum thickness of 335 ft. and is composed largely of cream-colored secondary dolomite.

On the basis of relict textures and fossils and comparison with data on the geologic framework of other reefs, 4 depositional environments are interpreted within Winnipegosis reef masses.

1. Open marine quiet water. Scattered crinoid ossicles occur in earthy to microsucrosic cream white to light buff secondary dolomite.

2. Open marine to slightly restricted highly agitated water. Oölitic and pisolitic textures are associated with corals, stromatoporoids, and algae(?).

3. Slightly restricted relatively quiet water. Very fine-grained pseudo-oölitic texture is present in dense to microcrystalline buff dolomite with only a trace of fossils.

4. Highly restricted relatively quiet water. Anhydrite occurs with interbedded secondary dolomite similar to the rock type described in 3.

The distribution of these interpreted environments suggests that atoll-like reefs existed in the Middle Devonian sea. It is believed that anhydrite was deposited in the central parts of the atoll lagoons during late stages as well as after cessation of reef growth. The reef masses were buried by a widespread salt unit (Prairie evaporite) 650-700 ft. thick in off-reef areas and 350-400 ft. thick over reefs. Although it is believed that much of this salt has been removed by post-depositional subsurface leaching, some of the reefs remain covered by 300-400 ft. of salt.

During the final phases of Prairie Evaporite sedimentation, red and green dolomitic shales (locally containing blebs of anhydrite) were deposited to form the "Second Red" (lowermost Dawson Bay). Thence open marine limestones containing brachiopods, crinoids, and stromatoporoids accumulated. This sequence culminated in deposition of salt and anhydrite (uppermost member of the Dawson Bay) followed by red dolomitic shale ("First Red").

Porosity and permeability within the Winnipegosis and Dawson Bay formations depend largely on 2 factors: (1) the original lithofacies and biofacies (the best porosity occurs in the interpreted Winnipegosis reef front and in dolomitized biostromes within the Dawson Bay), and (2) the amount of infilling of pores by secondary anhydrite and salt.

Petroleum accumulations may be expected at the updip limits of those Winnipegosis reefs that are presently buried and sealed by salt. Petroleum traps in the Dawson Bay formation may be caused by the possible irregular infilling of pores with salt and anhydrite. The most promising method of oil exploration in these units involves detailed lithofacies and biofacies analyses before and in conjunction with stratigraphic test drilling. --Auth.

1-1386. Abels, Thomas Allen. A SUBSURFACE LITHOFACIES STUDY OF THE MORROWAN SERIES IN THE NORTHERN ANADARKO BASIN: Shale Shaker, v. 9, no. 7, p. 5-21, 9 maps, March 1959, 35 refs.

In parts of the Northern Anadarko basin the Chester-Morrow contact is difficult to determine. Although Springer rocks have been tentatively identified in a few wells in the basin, they should probably be placed in the lower Morrow [Pennsylvanian]. Springer rocks may be found deeper in deeper parts of the basin in Hemphill County, Texas, and Custer and Roger counties, Oklahoma. At the beginning of Morrow time, the Cambridge arch and Nemaha, central Kansas, Sierra Grande, Cimarron, and Amarillo uplifts were structural highs. Major source areas for Morrow sediments in the basin were the central Kansas and Sierra Grande uplifts; minor amounts came from the Amarillo uplift and Cambridge arch. Early Morrow sediments filled topographic lows on a Mississippian erosion surface. Deltas were deposited along the eastern edge of the Northern Anadarko basin in early Morrow time. The Cimarron uplift was above or partially above sea level in early Morrow but covered by the sea in middle and late Morrow. The Dalhart basin was an integral part of the Northern Anadarko basin in the Morrow. In the western part of the Dalhart basin during the Morrow, sediments were laid down in a continental environment which graded eastward into a mixed continental and nearshore environment and, ultimately, in the Cimarron uplift, into a marine environment. Although impeded by an influx of detrital material, Morrow-time Northern Anadarko conditions were ideal for limestone deposition. A shale facies belt extending from southern Hamilton County, Kansas, through Stanton, Stevens, and eastern Morton counties, Kansas; eastern Texas and western Beaver counties, Oklahoma, and eastern Ochiltree, western Lipscomb, northwestern Hemphill, and east central Roberts counties, Texas, represents the axial portion of the Morrowan basin in which subsidence and deposition were greatest. The Northern Anadarko basin was marine in middle Morrow time. The Sierra Grande uplift came in late Morrow, when from it coarse clastics were deposited in offshore bars in southwestern Kansas and the Oklahoma and Texas panhandles. Late Morrow sediments were marine, lagoonal and paludal. Late Morrow sedimentation in the Northern Anadarko basin closed with a complete withdrawal of the sea. This was followed by the formation of coal-swamps in southwestern Kansas and the Oklahoma and Texas panhandles. The axis of the basin shifted slightly S. in post-Morrow, pre-Atokan time. There was very little erosion of Morrow sediments in southwestern Kansas and the Oklahoma-Texas panhandle prior to submergence by the Atokan sea. Morrow sediments in northwestern Kansas were not emerged until covered by the Des Moinesian "Cherokee" sea. The Atokan sea was less extensive than the Morrow sea. Pre-"Cherokee" Pennsylvanian rocks in northwestern Kansas are Morrow age and probably extend into the SW. corner of Nebraska. It is difficult to differentiate between Atokan, Morrowan and Des Moinesian sediments along the eastern edge of the Northern Anadarko basin.

A thick rock unit and a small map scale were used in this study. Detailed lithofacies studies involving thinner rock units and larger map scales may yield valuable results in determining the relationship between facies and oil and gas occurrence in Morrowan sediments. The Morrowan of the Northern Anadarko basin holds much promise for future oil and gas production. --From auth. concl.

1-1387. Williams, E. G., and Richard P. Nickelsen. **CORRELATION OF THE POTTSVILLE AND LOWER ALLEGHENY SERIES IN PARTS OF CLEARFIELD AND CENTRE COUNTIES:** Pennsylvania State Univ., Mineral Industries Expt. Sta., Bull. no. 71, p. 37-50, 1958.

Four identifiable coals occur in the Clarion formation of Clearfield County [Pennsylvania]. These are, in ascending order, the Brookville, Clarion No. 1, Clarion No. 2 and Clarion No. 3 coals. The Clarion No. 1 and No. 2 coals are splits of a single seam which is correlated with the lower Clarion coal of the type area. The Clarion No. 3, which also is a split of the Clarion coal, is correlated with the upper Clarion coal of the type area. Commercially valuable clay occurs beneath the lower Kittanning, Clarion No. 1 and the Brookville coals.

Five fossil zones, extremely valuable in correlation, have been found and described in the section extending from the Brookville to the lower Kittanning coal.

Three irregularly developed major sandstone bodies have been recognized in the Clarion formation - the Kittanning, which extends over most of the region studied and occurs between the lower Kittanning coal and the Clarion No. 3 coal; the Clarion, confined mainly to the area W. of Curwensville and occurring between the Clarion No. 1 and the Brookville coals; and a thick unnamed sandstone, confined to the area around Peale, which occurs between the Clarion No. 1 and No. 2 coals.

Thickness variations in the Clarion formation are in part structurally controlled as shown by thinning on the anticlines and thickening in the synclines. --Auth.

1-1388. Walker, Theodore R. **FOSSILIFEROUS MARINE REDBEDS IN MINTURN FORMATION (DES MOINES) NEAR McCOY, COLORADO:** Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 1069-1071, illus., May 1959, 5 refs.

Arkose, arkose conglomerate, shale, and some of the limestone of the Minturn formation, of Des Moines age (Pennsylvanian), near McCoy, Colorado, are red and yet on the basis of contained fossils are definitely marine beds. The red color is due to hematite which has been preserved because 1) the volume of hematite deposited with the beds was exceptionally high, 2) the reducing capacity of the marine environment was low, and 3) the sedimentation and subsidence rates were rapid. --M. Russell.

1-1389. Searight, Walter V. **PENNSYLVANIAN (DESMOINESIAN) OF MISSOURI:** Missouri, Div. Geol. Survey & Water Resources, Rept. Inv. no. 25, 46 p., 30 figs., 9 pls., table, 1959; reprinted from: Geological Society of America, Field Trip Guidebook, St. Louis Meeting, 1958.

W. of the Ozarks, in western Missouri, southeastern Kansas, and northeastern Oklahoma, a very complete succession of coal-bearing Pennsylvanian strata lies between the Mississippian and the top of the Desmoinesian rocks. These beds, as they are displayed in western Missouri, are typical and representative of the platform deposits of the northern midcontinent. Coal beds occur in cyclic or sedimentary successions, and it is in this area that coal beds are most numerous and depositional successions similar to each other are most frequently repeated. The strata covered by the guidebook include beds from the basal contact of the Pennsylvanian upward into the Pawnee of the lower Marmaton group.

These Pennsylvanian deposits thin greatly N. of the Ozarks by overlap and by the non-deposition or suppression of certain lithologic units. Thus, the Krebs and Cabaniss subgroups as well as the Marmaton group are fully represented in western Missouri. N. of the Ozarks the Krebs group appears to be entirely lacking between the Cabaniss and Cheltenham clays, and several cyclic successions of the Cabaniss subgroups are lacking or so thin as to be unrecognizable. Lower Marmaton beds, however, are continuous across the State from Kansas to the Mississippi River and appear to have continued across the Lincoln fold eastward into Illinois where they lie on beds of Cygnian age closely comparable with Cabaniss rocks, which in turn rest on Venteran age rocks equivalent to the Krebs.

Marmaton beds overlap much older Pennsylvanian on the N. flank of the Ozarks where Marmaton beds are separated from Cheltenham clays by Cabaniss only a few inches thick. These features are illustrated by sections and cross sections, and stops were made on the field trip for study of these relationships. --Auth.

1-1390. Davis, John C. **REEF STRUCTURE IN THE PLATTSBURG AND VILAS FORMATIONS (MISSOURIAN) IN SOUTHEAST KANSAS:** Compass, v. 36, no. 4, p. 319-35, index map, secs., May 1959, 11 refs.

Stratigraphic studies of the Missourian (Pennsylvanian) Vilas and Plattsburg formations in Wilson and Montgomery counties, Kansas, indicate the presence of an organic reef and associated structures. The lithology and paleontology of the rocks in 10 measured sections is described and shown as a stratigraphic cross section. Abnormal thickness of the Spring Hill member of the Plattsburg formation, with a brecciated, algal lithology characteristic of reef structures, indicates that reef growth was confined to that member. Increased thickness of the overlying Vilas Shale formation S. of the reef structure is interpreted as filling of a back-reef lagoon.

This reef in the Plattsburg formation is similar to other reefs in the overlying Stanton formation. These reefs constituted a rather persistent organic barrier. They separated a clastic-laden neritic environment in northern Oklahoma from a normal clear, shallow sea prevalent over Kansas and the northern midcontinent during Missourian time. --Auth.

1-1391. Ball, S. M. **STANTON LIMESTONE IN NORTHEASTERN KANSAS:** Compass, v. 36, no. 4, p. 279-88, illus., map, May 1959, 14 refs.

Stratigraphy of the Stanton limestone (Missourian, Pennsylvanian) in northeastern Kansas and methods used in correlation are discussed. Stratigraphic evidence indicates that disconformity between Stoner and South Bend members of the Stanton limestone can be traced from Leavenworth County to Anderson County. --Auth.

1-1392. Mendoza, Herbert A. **WHITE CLOUD CHANNEL SANDSTONE:** Compass, v. 36, no. 4, p. 272-76, 4 illus., diag., May 1959, 2 refs.

The Upper Pennsylvanian White Cloud channel sandstone outcrops about 3 mi. W. of Topeka, Kansas.

From base upward it consists of 1) basal conglomerate, 2) micaceous, silty shale, 3) limey sandstone, and 4) interbedded micaceous shale and limey sandstone. It is flat lying and lacks cross-bedding, indicating deposition by a sluggish stream of low competency and high capacity. --M. Russell.

1-1393. Mixon, Robert B., Grover E. Murray, and Teodoro Díaz. AGE AND CORRELATION OF HUIZACHAL GROUP (MESOZOIC), STATE OF TAMAULIPAS, MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 757-71, 9 illus., 2 maps, Apr. 1959, 46 refs.

Field studies in the Huizachal anticlinorium, Sierra Madre Oriental, near Ciudad Victoria, Tamaulipas, Mexico, disclose that the Huizachal group (redbeds), formerly undivided, contains at least 2 mappable sequences, herein named La Joya formation and La Boca formation.

The La Boca formation consists mostly of red and green claystones, mudstones, siltstones, sandstones, and conglomerates and rests unconformably on (1) crystalline rocks of unknown age and (2) deformed Paleozoic strata lithically similar to those of the Marathon uplift (Texas). It is considerably folded and faulted and underlies either the La Joya formation (redbeds) or the overlying Zuloaga limestone (Late Jurassic) with angularity up to almost 90^{o}.

The La Joya includes (1) a lithically variable basal conglomerate, (2) a thin limestone and limestone conglomerate, (3) red mudstones, claystones, siltstones, and fine quartzose sandstones which grade upward into red, pink, or green, fine to very coarse, cross-bedded, quartzose sandstones, and red, pink, or green conglomerates. The La Joya possesses conformable to low angular unconformable relations with the superjacent Zuloaga limestone; it rests with considerable angularity on the La Boca formation and on deformed sediments of late Paleozoic age. At some places it overlies crystalline rocks probably Paleozoic and Precambrian in age.

Fossil plants from the upper part of the La Boca formation in Novillo Canyon indicate that this part of the group is probably late Triassic in age. The La Joya thus appears to be Jurassic in age, its general relations to the Zuloaga limestone (of definite Late Jurassic age) being such as to suggest that it might be Middle or Late Jurassic in age. --Auth.

1-1394. Robinson, Florence M., and Florence Rucker Collins. CORE TEST, SENTINEL HILL AREA AND TEST WELL FISH CREEK AREA, ALASKA: U. S. Geol. Survey, Prof. Paper 305-I, p. 485-521, 9 illus. (2 in pocket), May 1959, 7 refs.

Sentinel Hill core test 1 and Fish Creek test well 1 were drilled in 1947 and 1949, respectively, as part of the petroleum exploration of Naval Petroleum Reserve No. 4, northern Alaska, carried on by the U. S. Navy from 1944 to 1953. Fish Creek test well 1 is near an oil seep in the northeastern corner of the Reserve, which is in the Arctic coastal plain province; and Sentinel Hill is about 50 mi. to the S. Both holes were drilled into the youngest Cretaceous (the uppermost divisions of the Late Cretaceous Colville group) formations found in northern Alaska, and Fish Creek test well 1 penetrated several older Cretaceous formations as well. The strata are composed primarily of clay shale, with some sandstone and siltstone; most of the section is marine. Tuffaceous beds and bentonite are abundant in the upper part of the sequence. The 7,020-ft. test well at Fish Creek recovered a small amount of heavy black oil, but the core test, a much shallower hole, had no oil or gas shows. --Auth.

1-1395. Collins, Sam G. STRATIGRAPHIC CORRELATION IN THE PIERRE FORMATION BY CLAY MINERAL COMPOSITION: South Dakota Acad. Sci., Proc., v. 37, p. 142-44, 1959.

The present studies of the clays of the Pierre formation [Upper Cretaceous] from samples collected in the S.-central part of South Dakota are a continuation of previous studies by the author. An attempt is made to determine whether the quantitative variations in composition of the clays can be correlated to particular stratigraphic zones (members) within the formation. The clay minerals from samples collected were prepared and photographed on a General Electric XRD-1 X-ray powder diffraction camera in Cu K_a radiation. Line graphs were then made of the densities of the diffraction-line photographs with a recording optical densiometer and were sorted into 5 different configuration groups (by visual comparison) for samples from 4 stratigraphic members of the Pierre formation. Although there are recognized uncertainties arising from equipment available, methods used, and stratigraphic placement of the samples collected, the author feels that there is a definite possibility of stratigraphic correlation on the basis of clay minerals proportions. --D. Lum.

1-1396. Gries, John Paul. THE DAKOTA FORMATION IN CENTRAL SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 37, p. 161-68, 2 figs., 1959.

The historical background of the Dakota formation [Upper Cretaceous] is presented in a brief discussion. The proper correlation in central South Dakota resulted from a study of the electric log and samples of the Kadoka town water well in which the underlying shale was determined to be Skull Creek instead of Morrison, and the sandstone below that shale is, in part at least, the equivalent of the Inyan Kara sandstones of the Black Hills outcrop area instead of Morrison, Sundance, or even Pennsylvanian as previously thought. The proposed correlation of the shales and sandstones is presented in cross sections.

The Dakota sandstone lies in the shape of a high wedge and contains artesian water of great economic importance. Limited quantities of natural gas occur in a limited area in the central counties of the state. However, no oil has been produced to date. Fuller hydrological and geological studies are warranted. --D. Lum.

1-1397. Chubb, L. J. UPPER CRETACEOUS OF CENTRAL CHIAPAS, MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 725-56, 9 illus., geol. map, 3 tables, Apr. 1959, 53 refs.

The Tuxtla or Ocozocuautla formation has been attributed to various ages from Upper Jurassic to Eocene, and there has been controversy whether it lies below or above the thick rudist limestone which, under various names, has been referred to different ranges between Comanchean and Maestrichtian inclusive. A paleontological succession covering the range upper Turonian to Campanian has been pub-

lished, but without reference to the lithological succession. In this paper it is shown that the Ocozocuautla series is above the rudist (Sierra Madre) limestone, its lithological and paleontological successions are described, and correlated with each other and with the standard succession. The Sierra Madre limestone is shown to embrace the range from Lower Cretaceous to Turonian, the Ocozocuautla series being Campanian and Maestrichtian. No evidence was found of the occurrence of Coniacian or Santonian rocks, which are thought to be absent. The discrepancies between the conclusions reached in this paper and those of earlier authors are discussed, and their reasons investigated. --Auth.

1-1398. Nagappa, Yedatore. FORAMINIFERAL BIOSTRATIGRAPHY OF THE CRETACEOUS-EOCENE SUCCESSION IN THE INDIA-PAKISTAN-BURMA REGION: Micropaleontology, v. 5, no. 2, p. 145-92, 11 figs., 4 charts (1 fold.), 11 plates, 9 tables, Apr. 1959, 136 refs.

The available stratigraphic and foraminiferal evidence from the Upper Cretaceous-Eocene succession of the various parts of the India-Pakistan-Burma region is presented; a synthesis of this evidence shows that there were 4 main cycles of deposition. Each cycle is shown to have started with a transgression and ended with a regression. Evidence of minor local regression is present in some places. The earliest of these cycles ended with the Maestrichtian, and this is taken to indicate the end of the Cretaceous period. The next cycle started with the Danian, which is now placed in the lowermost Tertiary (basal Paleocene), and continued into the Ranikot stage (Paleocene). The third and fourth cycles began with the Laki and the Khirthar stages, respectively, the 2 cycles together representing the whole of the Eocene. --Auth.

1-1399. Crowell, John C., and Takeo Susuki. EOCENE STRATIGRAPHY AND PALEONTOLOGY, OROCOPIA MOUNTAINS, SOUTHEASTERN CALIFORNIA: Geol. Soc. America, Bull., v. 70, no. 5, p. 581-92, 4 figs. incl. map, 2 secs., 3 pls. incl. fold map, scale 1 in. to 1 mi., May 1959, 18 refs.

Marine Eocene strata underlie about 26 sq. mi. in the northeastern Orocopia Mountains, Riverside County, California. The newly discovered section, which is about 4,800 ft. thick, lies in a structural trough within basement rocks and is overlain unconformably by about 5,000 ft. of undated nonmarine clastic and volcanic rocks.

The Eocene beds consist of interbedded siltstone, sandstone, conglomerate, and breccia with some sandy limestone and are here defined as constituting the Maniobra formation. On the E. at the base of the section large granitic boulders up to 30 ft. in diameter lie along the unconformity with basement granite. These give way upward to thick lenses of coarse granitic conglomerate and breccia with interbeds of buff siltstone and arkosic sandstone. The upper part of the section on the E. consists of massive buff siltstone with sandstone and boulder beds. On the W. the section consists largely of interbedded siltstone and sandstone with conspicuous isolated boulders of granite.

Mollusks and Foraminifera, including Orbitoids, occur at many localities throughout the section. Some characteristic forms are: Turritella andersoni cf. lawsoni Dickerson, Turritella uvasana cf. applini Hanna, Clavilithes sp., Marginulina mexicana (Cushman) var., Pseudophragmina (Proporocyclina) clarki (Cushman). This fauna indicates a lower and middle Eocene age, and the strata possibly correlate with similar rocks of the Coast Ranges. --Auth.

1-1400. Bradley, Wilmot H. REVISION OF STRATIGRAPHIC NOMENCLATURE OF GREEN RIVER FORMATION OF WYOMING: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 1072-1075, May 1959, 7 refs.

The beds in the Bridger Basin formerly thought to be the Laney shale member of Schultz is recognized as a new member of the Green River formation (Eocene) and named the Wilkins Peak member; type locality Wilkins Peak, Sweetwater County, Wyoming. The Morrow Creek member of Bradley is recognized to be equivalent to the Laney shale member of the Green River formation, and the name Morrow Creek member is thus abandoned. The Tower sandstone lentil is redefined as a lentil in the Laney shale member of the Green River formation. --M. Russell.

1-1401. Ritter, John R., and Roger G. Wolff. THE CHANNEL SANDSTONES OF THE EASTERN SECTION OF THE BIG BADLANDS OF SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 37, p. 184-91, 3 figs., 1959.

This investigation is concerned with the determination of the source of sediments and old flow direction of the stream channels in the Scenic member of the Brule formation [Oligocene]. The results of field studies indicate a single stream with minor tributaries that flowed in a S. 45°E. direction. The channel fills are generally 105 ft. above the base of the Brule formation and usually 70-100 ft. wide and 6 to 8 ft. thick. Mineralogic and petrographic studies were performed in the laboratory. Histograms are plotted. The similarity of mineral assemblage found in the channel samples and the geometric projection of the channel both indicate the northern Black Hills as the source area. Comparative results indicate that it is improbable for channel streams in the eastern Badlands to be a continuation of the channel streams found in the Sheep Mountain Table area in the western Badlands. --D. Lum.

1-1402. Seefeldt, David R., and Melvin O. Glerup. STREAM CHANNELS OF THE SCENIC MEMBER OF THE BRULE FORMATION, WESTERN BIG BADLANDS, SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 37, p. 194-202, 4 figs., 1959.

The channel fills [in this member of the Oligocene Brule formation] which are lenticular in shape, characteristically green in color contrasting with the buff-colored stratigraphic sequence, and cliff-forming, are studied to determine the source area of the sediments and the stream direction; also to compare the results with studies of the stream channels of the eastern Big Badlands. The mineral assemblage of the channel fills indicate the southern Black Hills area as the source area. The streams flow NW. to SE., parallel to the streams in the eastern Big Badlands, and are separate stream systems. The streams studied in the present investigation are braided and meandering while those of the eastern Big Badlands are not braided but do meander. Other comparisons of the channel fills of the 2 areas are discussed. --D. Lum.

1-1403. Houston Geological Society, Houston, Texas. THE FRIO FORMATION OF THE UPPER GULF COAST OF TEXAS: Its: Study Group Rept. 1958-1959, 14 p., 3 fold. maps, diag. sec., tables, 1959, ref.

This paper presents results of an attempt to outline sand facies in the upper and lower Frio in the Upper Texas Gulf Coast. Due to the limitations of the material available for use and the nature of the transgressive and regressive cycles of deposition in the stratigraphic intervals studied, a number of assumptions have been made and several techniques have been utilized which depart from a purely scientific approach. These have been discussed in the text. When the maps are used in conjunction with the previously published cross sections, a better understanding of the cycles of deposition, the intertonguing of facies, and the oscillating embayments of deposition in the Upper Gulf Coast Frio section can be derived. Data utilized are presented in tabular form to permit further refinement or detailed study.--Auth. summ.

1-1404. Taft, William H. THE OGALLALA GROUP OF SOUTH-CENTRAL SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 37, p. 146-47, 1959.

The Ogallala group (Pliocene) in Gregory and Tripp counties is composed of arkosic sandstones (1/2 mm. to 1/16 mm.) which vary from friable to compact, have no cementation to silica or carbonate, and contain sporadic layers of volcanic ash. The group consists of the Ash Hollow conformably overlying the Valentine formation with the Bijou formation found within each. Petrographic studies suggest the following information about the sediments: (1) in its source area, mechanical weathering exceeds chemical weathering; (2) transportation from source area occurred during excessive rainfall and runoff; (3) during dry spells, wind erosion caused frosting of the sand grains; (4) opal was introduced after deposition. --D. Lum.

1-1405. Terasmae, J. TERMINOLOGY OF POST-VALDERS TIME: A DISCUSSION: Geol. Soc. America, Bull., v. 70, no. 5, p. 665-66, May 1959, 10 refs.

In discussion, J. Terasmae points out that William S. Cooper (in a previous paper; Geol. Soc. America, Bull., v. 69, p. 941-45) placed too much reliance on temperature distinctions in arriving at a basis for terminology and discusses several instances where known temperature variations from place to place would preclude precise timing of events on that basis.

In reply, Cooper admits his terminology allows for oversimplification but claims it to be based on the most prevailing view, namely that temperature has been the dominating factor in late-Pleistocene history. --M. Russell.

1-1406. Hopkins, David M. CENOZOIC HISTORY OF THE BERING LAND BRIDGE: Science, v. 129, no. 3362, p. 1519-28, 7 maps, 3 graphs, June 5, 1959, approx. 50 refs.

The interpretation of the Cenozoic history of the Bering land bridge offered in this article, resting as it does upon a synthesis of fragmentary data from many areas and several disciplines, must be regarded as tentative and rather speculative. Each new collection of Cenozoic mollusks from western Alaska, each new stratigraphic study of another coastal plain area along the Bering or Chukchi coast, each new radiocarbon date relating to a position of sea level, can force some modification of the history... Much could be learned from submarine cores on the Bering-Chukchi platform deep enough to penetrate through the Recent marine sediments into older deposits. The most serious gap in present knowledge, however, is the lack of data on the stratigraphy and structure of the sediments in the deformed marine terraces of western Seward Peninsula adjoining Bering Strait; future studies in this area may result in profound modifications of the history proposed here.

Though uncertainties persist, to be resolved by future work, these generalizations accord with the information now available. (1) The data of vertebrate paleontology suggest strongly that a seaway existed across the Bering-Chukchi platform during middle Eocene time, but physical evidence of its existence has not yet been found in Alaska or on the islands of the Bering Sea. (2) The Bering-Chukchi platform was a land area during most of the remainder of the Tertiary period. (3) A seaway across the Bering-Chukchi platform came into existence after middle Pliocene time and earlier than the beginning of the Pleistocene epoch. (4) The continents were separated by a seaway on the Bering-Chukchi platform during each interglacial interval of the Pleistocene, and they were connected by a land bridge during each glacial interval. (5) Rising sea level eliminated the land bridge for the last time between 10,000 and 11,000 years ago. (6) During Wisconsin time the land bridge had an arctic climate characterized by cold summers and severe winters; it supported treeless tundra vegetation; and animals migrating between the continents had to adapt to life in a tundra environment. The same conclusion is applied, with less conviction, to intercontinental land connections on the Bering-Chukchi platform during earlier glacial intervals. --Auth. concl.

1-1407. Williams, E. G. ASPECTS OF THE PALEOGEOGRAPHY OF THE COAL MEASURES OF WESTERN PENNSYLVANIA: Mineral Industries, v. 28, no. 9, p. 1, 3-5, 5 figs., June 1959, 5 refs.

Some aspects of the paleogeography of parts of the lower Coal Measures of western Pennsylvania have been reconstructed by cross-bedding and paleontological studies. A classification of observed invertebrate fossils into marine, brackish, and freshwater groups and the determination of the geographic distribution of these groups for selected rocks units constitutes the basic data upon which the paleogeographic interpretations are made. These interpretations are supported by cross-bedding data.

Faunal distribution maps for 2 of the marine, fossiliferous beds, the Mercer and the lower Kittanning, and cross-bedding maps of sandstone associated with these beds are presented. These maps show that in Mercer time, a shallow sea invaded western Pennsylvania from the SW. and extended across the entire width of the Allegheny Plateau. During lower Kittanning time, a shallow sea invaded Pennsylvania from the W. and extended across the central and northern parts of the plateau. Based on the distribution of fossils and cross-bedding data, the Mercer marine basin was filled with sediment derived from the N. and NE., in the vicinity of the Canadian Shield; the lower Kittanning marine basin was filled with sediment derived from the S. and SE., in the vicinity of the Appalachian mountain province.

The application of the paleogeographic maps to economic problems are considered by discussing some possible relationships between sedimentary environments of mapped beds and the composition, correlation, and mining of the associated coal and clay beds. --Auth.

1-1408. Broecker, Wallace S., and Alan F. Walton. RE-EVALUATION OF THE SALT CHRONOLOGY OF SEVERAL GREAT BASIN LAKES: Geol. Soc. America, Bull., v. 70, no. 5, p. 601-618, 11 figs., 2 tables, May 1959, 33 refs.

A re-evaluation of methods used to calculate the accumulation time for salts in the Great Basin lakes indicates that they are based on questionable assumptions and yield ages which are probably a factor of 10 too small. A new approach to such calculations has been applied to Great Salt, Mono, Pyramid, and Walker lakes. The Cl^- concentration in rainfall entering the basin is used instead of the rate of Cl^- addition to these lakes as determined from chemical data on river waters. Loss of Cl^- from the surface of the lake must be taken into account, particularly when the Cl^- concentration is large. The effect of changes in climate on the rates of salt input and loss must also be considered. Radiocarbon data provide an absolute climate chronology and allow these variations to be handled quantitatively.

The study suggests that Great Salt Lake and Mono Lake have not lost a major portion of their salt by desiccation for more than 73,000 years. Pyramid Lake may also have been in existence since the end of the last interpluvial period (i.e., $\sim$ 73,000 years B.P.), but Walker Lake must have desiccated during the last 10,000 years. Such histories are internally consistent and in good agreement with independent biological and geological evidence. --Auth.

A discussion by J. H. Feth is abstracted below.

1-1409. Feth, J. H. RE-EVALUATION OF THE SALT CHRONOLOGY OF SEVERAL GREAT BASIN LAKES: A DISCUSSION: Geol. Soc. America, Bull., v. 70, no. 5, p. 637-40, 2 tables, May 1959, 11 refs.

The writer feels that Broecker and Walton [see abstract above] have contributed interesting concepts - notably, removal of salt from inland basins by wind entrainment - to an attempt to derive a salt chronology for the lakes with which they dealt. It appears, however, that they made no allowance for geologic and ground-water increments of chloride that, in Great Salt Lake especially, are overwhelmingly important; they seemingly disregarded the geologic environment and the complex nature of Mono Lake; and they made no provision for variation in Cl^- concentration with recognized climatic fluctuations during Pleistocene time. For these reasons, the present writer cannot accept the ages calculated by Broecker and Walton as reliable even within reasonable limits. --Auth. summ.

1-1410. Greenhalgh, D., and P. M. Jeffery. A CONTRIBUTION TO THE PRE-CAMBRIAN CHRONOLOGY OF AUSTRALIA: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 39-57, 3 maps, graph, 7 tables, May 1959, 27 refs.

The results of quantitative chemistry combined with isotope analyses by mass spectrometry have been used to compute a number of mineral ages by the U-Pb method.

The ages of U minerals from various parts of Australia have in most cases been in agreement with the previously accepted geologic interpretations. Two periods of U mineralization have been confirmed in the Northern Territory U mining fields (late Archean and upper Proterozoic), and at Crocker's Well in South Australia (Archean and upper Proterozoic). Two periods of mineralization have been postulated for the U mineralization at Radium Hill (Archean and Proterozoic) and for the Pb mineralization at Broken Hill (Archean and Cambrian). The U mineralization at Myponga, South Australia, and Hart's Range, Central Australia, has been dated as upper Proterozoic, and at Woodstock, Western Australia, as Archean. Where suitable samples were available K-Ar ages have been used to provide additional evidence as to the correctness or otherwise of the U-Pb determinations. A "concordia" diagram did not satisfactorily resolve discordant ages, and it is concluded that Rn losses may generally be expected to vitiate this method.

A set of 4 figure tables is presented for conversion of isotopic ratios to geological ages. --Auth.

1-1411. Huffman, George G. PRELIMINARY ISOPACHOUS AND PALEOGEOLOGIC STUDIES, CENTRAL MID-CONTINENT AREA: Shale Shaker, v. 9, no. 8, p. 5-21, 12 maps, Apr. 1959, 15 refs.

Shallow seas covered much of the central mid-continent area during the Paleozoic era. Geosynclinal conditions prevailed in southern Oklahoma and Texas where maximum deposition of early and middle Paleozoic strata took place in the NW.-trending Wichita-Arbuckle geosyncline. A second geosyncline, the Ouachita, occupied southeastern Oklahoma and central Texas. The latter was the site of deposition of thick clastic sediments, especially in late Paleozoic time.

Northern Oklahoma, Kansas, southeastern Colorado, and adjacent areas remained relatively stable until early Pennsylvanian time and received typical shelf-type deposits. Epeirogenic movements were relatively uniform from late Cambrian until late Devonian (post-Hunton, pre-Chattanooga) at which time strong warping and local uplifting occurred. Markedly affected at this time were the Ozark uplift and the Wichita-Amarillo-Criner axis along which later folding was to occur.

Major orogenic movements in post-Mississippian and pre-Des Moinesian (post-Morrowan) produced most of the tectonic features of the central mid-continent area. Post-Morrowan movements included uplift of the Ouachita area; folding of the Amarillo-Wichita-Criner uplift; formation of the Hollis basin, Anadarko basin, Marietta syncline, Ardmore basin, Forest City basin, Salina basin, and Hugoton embayment; uplift of the Nemaha ridge, central Kansas uplift, Las Animas and Sierra Grande arches, and the Hunton-Tishomingo-Pauls Valley structure.

Renewed folding in late Missourian (Hoxbar) resulted in formation of the Arbuckle Mountains and a refolding of the Amarillo-Wichita-Criner elements. Late Pennsylvanian movement affected primarily the Marathon-Ouachita system of the southern mid-continent region.

Final structural development, especially in the central Colorado area, culminated in late Cretaceous and early Tertiary time with the Laramide orogeny which folded and thrust-faulted the Rocky Mountain area and elevated the foothills, giving eastward dip to the Mesozoic strata of western Oklahoma and Kansas. --Auth. summ.

1-1412. Bercutt, Henry. ISOPACHOUS AND PALEOGEOLOGIC STUDIES IN EASTERN OKLAHOMA NORTH OF THE CHOCTAW FAULT: Shale Shaker, v. 9, no. 6, p. 5-20, 16 maps, chart, Feb. 1959.

The stratigraphy, structure, paleogeography, and geologic history is described of 13,104 sq. mi. of NE. Oklahoma, N. of the Choctaw fault. Rocks in the area range from Precambrian Spavinaw granite to Upper Pennsylvanian Ochelata group, but details are limited to rocks of pre-Des Moinesian age

The thickness of units are shown by 10 isopachous maps; the paleogeography by 2 maps, and the structure by 2 maps. Scales of maps are about 35 mi. to the inch and 25 mi. to the inch. --M. Russell.

1-1413. Bick, Kenneth F. STRATIGRAPHY OF DEEP CREEK MOUNTAINS, UTAH: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 1064-1069, table, May 1959, 7 refs.

The writer has made the following additions and corrections to the stratigraphy of the Deep Creek Mountains, Utah, as it was originally outlined by Nolan in 1935.

1. The Prospect Mountain quartzite has been restricted and a new formation, the Goshute Canyon formation, proposed for the lower half of what was formerly called the Prospect Mountain.
2. The name Cabin shale has been dropped in favor of Pioche shale.
3. The reported unconformity between the Hicks formation and the Chokecherry dolostone, supposed to mark the Cambro-Ordovician boundary, is nonexistent.
4. The Cambro-Ordovician boundary lies within the Chokecherry dolostone at the change from thick-bedded to thin-bedded rocks.
5. The lower third of the Chokecherry dolostone is Late Cambrian in age. The upper part is Early Ordovician in age, containing fossils as young as Black Rock age.

Except as noted, the Cambrian through Devonian stratigraphy as outlined by Nolan is substantiated by this study. --Auth. summ.

1-1414. Keefer, William R. STRATIGRAPHY OF NORTHWESTERN PART OF WIND RIVER BASIN, DUBOIS AREA, WYOMING: Am. Assoc. Petroleum Geologists, Bull. v. 43, no. 5, p. 1080-1084, May 1959, 50 refs.

A recent paper by C. C. Reeves, Jr., titled, "Stratigraphy of Northwestern Wind River Basin and Range, Dubois Area, Fremont County, Wyoming," published in the Oct. 1958, issue of the AAPG Bulletin [Geological Abstracts, v. 6, no. 4, p. 57], describes an area that has been the subject of many other geologic studies in recent years. The object of the present discussion is to summarize, for the benefit of readers unfamiliar with the geologic literature of the region, pertinent data from published references not cited by Reeves. --Auth. introd.

5. PALEONTOLOGY

See also: Stratigraphy 1-1398, 1-1399.

1-1415. Langenheim, R. L., Jr. RECENT DEVELOPMENTS IN PALEONTOLOGY: Jour. Geol. Education, v. 7, no. 1, p. 4-9, Spring 1959, 17 refs.

Current major trends in paleontologic work include increased emphasis on paleoecology, critical re-evaluation of the concepts of stratigraphic paleontology, and revision of the systematics of fossil invertebrates. The Treatise on Marine Ecology and Paleoecology, and "Notes" and "Reports" of the American Stratigraphic Commission and the Treatise on Invertebrate Paleontology respectively present the more significant results of this work. Recent individual discoveries of interest are: (1) structurally preserved microfossils from the Huronian, (2) geochemical studies of organic compounds from the Precambrian, (3) Cambrian lycopsids(?), (4) the fruiting bodies of Glossopteris and Gangamopteris, (5) Triassic palmlike plants, (6) the extreme morphologic and ontogenetic variability of some living foraminifers, (7) a living representative of the Monoplacophora, and (8) silicified insects from the Miocene. --Auth.

1-1416. Newell, Norman D. ADEQUACY OF THE FOSSIL RECORD: Jour. Paleontology, v. 33, no. 3, p. 488-99, 2 figs., May 1959, 27 refs.

During the history of the Paleontological Society there have been many important developments in paleontology. In addition to steady increase in knowledge through new fossil discoveries, increasing attention is being given to ecological and evolutionary processes, and there is growing concern with theory and principles in both the biological and geological aspects of paleontology. There is, however, a neglect of comparative morphology and taxonomy, and there are far too few expert paleontologists to cover the work to be done.

For a qualified few who recognize the challenge, opportunities are almost unlimited in paleontology for significant studies of comparative morphology, systematics, evolution, stratigraphic facies, paleoclimatology, and the general history of life. The utilitarian value of fossils as stratigraphic indicators is, and will always be, an important aspect of paleontology. But, as requirements become ever more exacting, stratigraphic paleontology calls for skilled preparation of fossils and expert knowledge of their biological nature beyond the abilities of the nonspecialist.

Intensive stratigraphic studies in all parts of the world, and the development of improved methods of collecting and preparing fossils have revealed a fossil record much richer than was envisioned by the founders of the Paleontological Society. There are now substantial reasons for believing that the available record is still very incompletely known. Much remains to be learned about the processes by which organisms are preserved as fossils. --Auth.

1-1417. Collinson, Charles W. GUIDE FOR BEGINNING FOSSIL HUNTERS: rev. ed., Illinois, State Geol. Survey, Education Ser. 4, 39 p., 11 pls., 1959, refs.

Various types of fossils found in Illinois are described in simple language. The nature and origin of fossils are discussed briefly, and information about finding, collecting, and identifying them is given. Numerous illustrations are included

to make identification of the most common fossils easy for the beginner.

A map of the famous Mazon Creek plant fossil collecting area is included. --Auth.

1-1418. Wilson, L. R. A WATER-MISCIBLE MOUNTANT FOR PALYNOLOGY: Oklahoma Geology Notes, v. 19, no. 5, p. 110-111, May 1959.

Clearcol, a water-miscible liquid, has proved to be an excellent mountant for palynological materials. Fossils contained in water or acetic acid can be mixed with Clearcol which drys to a clear noncrystalline solid in a low temperature oven. The mountant has a refractive index of approximately 1.4. A very satisfactory method of preparing palynological slides with Clearcol is as follows: place one to several drops of the mountant on a microslide cover glass and add a drop of water containing fossils. The liquids are gently mixed but not spread to the edges of the cover glass. The cover glass is then placed in an oven whose temperature does not exceed 40° C. In approximately 20 min. the mixture will be dry and the cover glass can be mounted, preparation-side down, on a microslide using as an adhesive, Canada balsam or other permanent mounting medium--Auth.

1-1419. Rigby, J. Keith, and Richard W. Moyle. SOME MISSISSIPPIAN AND PENNSYLVANIAN SPONGES FROM UTAH: Jour. Paleontology, v. 33, no. 3, p. 399-403, fig., pl., May 1959, 8 refs.

The 2 previously described species of Wewokella and Talpaspongia clavata King occur in the uppermost Mississippian part of the Manning Canyon formation in the Oquirrh Mountains, which is the earliest occurrence known to date. Annulispongia interrupta, a new dictyid form of the Titusvilliidae, occurs in the lowermost Pennsylvanian part of the same formation in the same area. Talpaspongia and Annulispongia occur consistently in limestone, and Wewokella occurs in shale, suggesting a relationship of shallow cloaca in a turbid environment. --Auth.

1-1420. Koenig, John W., and Walter Niewoehner. PENTECECRINUS, A NEW MICROCRINOID FROM THE LOUISIANA FORMATION OF MISSOURI: Jour. Paleontology, v. 33, no. 3, p. 462-70, 3 figs., May 1959, 39 refs.

A new microcrinoid, Pentececrinus parvus (suborder Cyathocrinoidea), from the Louisiana formation (Devonian-Mississippian) of Missouri is described and compared with other nonbrachiate crinoids possessing only 3 circlets of plates (IBB, BB, OO) and an anal. Such crinoids have been reported from the Mississippian, Pennsylvanian, and Permian of the United States, the lower Carboniferous of Europe, and the Permian of Timor and Russia. With the addition of Pentececrinus, it is inferred that they form a phyletic group extending from late Devonian or early Mississippian to Permian time and that known Permian representatives do not indicate regressive evolution or aberrant specialization. --Auth.

1-1421. Cramer, Howard Ross. DEVONIAN STARFISH FROM PIKE COUNTY, PENNSYLVANIA: Jour. Paleontology, v. 33, no. 3, p. 471-73, illus., May 1959, 3 refs.

Hudsonaster wardi, n. sp., an asteroid, is described from the Ludlowville member of the Mahantango formation near Milford, Pennsylvania. This genus has hitherto been known only from the Ordovician.

The starfish exhibits such "primitive" characteristics as few, heavy, nonstellate plates around the disc, and has no accessory ossicles in the arms or disc.

However, this starfish possesses such "advanced" characteristics as having the superomarginal plates almost completely overlap the inferomarginal plates from the apical side. This feature was predicted by Schuchert to be found in post-Ordovician members of the family Hudsonasteridae.

The associated abundant fauna is widespread over the area, and a warm marine environment is suggested. "Storm rollers" indicate that the shallow water was occasionally agitated by strong waves. --Auth.

1-1422. Howell, B. F. THREE NOTES ON SILURIAN WORM GENERA: Jour. Paleontology, v. 33, no. 3, p. 487, May 1959.

The names of 2 genera of Silurian "worms" as proposed by Rudolf Ruedemann in 1925 are preoccupied and new names are proposed. They are Lockportia for Dactylethra, and Ruedemanella for Bertiella. The Silurian serpulid worm described by J. W. Salter in 1848 as Serpulites curtus is not properly that genus and the new name Sinuocornu curtum is proposed. --M. Russell.

1-1423. Skogstrom, H. Clifford, Jr. THE PALEOECOLOGICAL SIGNIFICANCE OF TANCREDIA AMERICANA: South Dakota Acad. Sci., Proc., v. 37, p. 139-41, 1959.

Fossils of Tancredia americana, heterodont pelecypod are found locally abundant in the Timber Lake member of the Fox Hills formation [Upper Cretaceous] in northern South Dakota. These fossils are most abundant in a light-brown to dark-reddish brown, medium- to fine-grained, friable, limonitic sandstone. An average-sized fossil valve is about 43 mm. in length, 32 mm. in height, and 13 mm. in breadth. The valve shell is about 2 mm. thick. The condition of the fossils indicate that they were subjected to abrasive action for a short period of time and that they were transported only short distances. The size and thickness of the fossils also indicate a warm water environment. It is tentatively concluded that the shallow burrowing pelecypod occupied an environment of warm water and a flat sandy bottom which was void of extreme conditions of abrasive action. --D. Lum.

1-1424. Stevenson, Robert E. THE INOCERAMUS LABIATUS COMMUNITY OF UPPER TURONIAN (GREENHORN) TIME: South Dakota Acad. Sci., Proc., v. 37, p. 136-38, 1959.

The basic ideas and concepts for paleoecological descriptions are described. The species Inoceramus labiatus whose fossils are found in the Greenhorn formation is the dominant member of a marine bottom community of the Late Cretaceous trans-American sea (North and South Dakota, Wyoming, Nebraska, Colorado, and Kansas). It is dysodont pelecypod of the family Pernidae and exhibits the requirements for being a diagnostic species; that is, long-lived, nonpredatory, and immediately conspicuous. The ecological conditions controlling the environment

of this community are outlined, including character of the marine water, the sediments and the associated fauna.--D. Lum.

1-1425. Hall, Clarence A., Jr. THE GASTROPOD GENUS CERATOSTOMA: Jour. Paleontology, v. 33, no. 3, p. 428-34, 4 figs. incl. map, 3 pls., May 1959, 38 refs.

The species belonging to the genus Ceratostoma are listed and some are figured, as are forms that closely resemble the genus. The genus is characterized by 3 varices, foliations on the varices, and a tooth on the anterior portion of the outer lip. The genus Ceratostoma lives in a littoral marine environment with water temperatures ranging from 2^{o} to 27^{o} C. Known time range of the genus is from the middle Miocene to the Recent. --Auth.

1-1426. Branson, Carl C. TYPE LOCALITY OF EARLIEST KNOWN OKLAHOMA FOSSIL: Oklahoma Geology Notes, v. 19, no. 5, p. 101-102, May 1959.

The type locality of Goniatites choctawensis Shumard is near the village of Weathers in southeastern Pittsburg County or southwestern Latimer County, Oklahoma. --M. Russell.

1-1427. McGowran, B. TERTIARY NAUTILOIDS (EUTREPHOCERAS AND CIMOMIA) FROM SOUTH AUSTRALIA: Jour. Paleontology, v. 33, no. 3, p. 435-48, 11 figs. incl. map, 3 pls., May 1959, 27 refs.

Eutrephoceras altifrons (Chapman) and E. geelongensis (Foord) from the lower Miocene of South Australia, intergrade with respect to most characters. They differ, however, in the shape of the umbilical shoulders. The 2 species, which occur together, are redefined, and Kummel's assignment of them to Eutrephoceras is accepted.

The study of new specimens of Nautilus felix Chapman from the upper Eocene of the Adelaide Basin indicates that this species belongs to Cimomia. Cimomia yorkensis n. sp. is described from beds of the same age. --Auth.

1-1428. Moore, Raymond C., ed. TREATISE ON INVERTEBRATE PALEONTOLOGY. PART O. ARTHROPODA 1. ARTHROPODA - GENERAL FEATURES, PROTARTHROPODA, EUARTHROPODA - GENERAL FEATURES, TRILOBITOMORPHA, by H. J. Harrington, Gunnar Henningsmoen, B. F. Howell, Valdar Jaanusson, Christina Lockman-Balk, Raymond C. Moore, Christian Poulsen, Franco Rasetti, Emma Richter, Rudolf Richter, Herta Schmidt, Klaus Sdzuy, Wolfgang Struve, Leif Størmer, C. J. Stubblefield, Ronald P. Tripp, J. Marvin Weller, and H. B. Whittington: 560 p., 415 figs., New York and Lawrence, Kansas, Geological Society of America and University of Kansas Press, 1959, refs.

The 4 parts on arthropods, of which this is the first part, are in turn a unit of a planned 24-part comprehensive and authoritative treatise on invertebrate fossils. A section, "General Features of Arthropoda" is followed by systematic descriptions of Protarthropoda, and Euarthropoda which includes the Trilobitomorpha. A glossary of morphological terms applied to Trilobita, bibliographies, and an index are included. Systematic descriptions are given down to subgenus. Line drawings and photographs illustrate diagnostic features. The classification of Trilobita recognizes 1,401 genera, grouped ultimately under 7 orders with 13 suborders. Description of Arthropoda includes morphology, geological occurrence, phylogeny and classification. Two orders of Protarthropoda, 2 classes of the subphylum Trilobitomorpha (the Trilobitoidea and Trilobita) are defined and described. Under the "General Description of Trilobita" significant points covered include morphology of exoskeleton, sensory organs, internal anatomy, enrollment of the animal, color patterns, cicatrization, regeneration, pathology, and teratology. The systematic descriptions include taxon, name, author, date of name, synonymy, type species, diagnostic characteristics, geologic distribution, and geographic occurrence. --M. Russell.

1-1429. Rasetti, Franco. TREMPEALEAUIAN TRILOBITES FROM THE CONOCOCHEAGUE, FREDERICK, AND GROVE LIMESTONES OF THE CENTRAL APPALACHIANS: Jour. Paleontology, v. 33, no. 3, p. 375-98, 2 figs., 5 pls., May 1959, 33 refs.

The Conococheague formation of the Cumberland-Shenandoah valleys of Pennsylvania, Maryland, and Virginia was known to represent most of the Croisian series, but only a few Franconian and 2 Trempealeauian fossils had been published. A faunule of Trempealeauian age including 15 species is described from the upper Conococheague of Pennsylvania and Maryland. The Frederick limestone of Maryland yielded 19 species of Trempealeauian trilobites, of which only one was previously known from the formation. The overlying Grove limestone, hitherto considered entirely Lower Ordovician on the basis of brachiopods and cephalopods collected in the upper part of the formation, yielded a faunule of 11 Trempealeauian trilobites near the base, indicating that the Cambrian-Ordovician boundary lies within the formation. All these faunules have many genera and species in common with the Hungaia magnifica boulders at Levis, Quebec, the Gorge formation of northwestern Vermont, and the Eminence dolomite of the Ozark uplift.

One new genus, Conococheaguea (type species: C. ovata, n. sp.) and the following new species are described: Apatokephaloides macrops, A. minor, Aposolenopleura plicata, Bowmania pennsylvanica, Keithia intermedia, Idiomesus intermedius, Levisella nasuta, Prosaukia corrugata, Richardsonella subcristata, and Triarthropsi limbata. --Auth.

1-1430. Shaw, Alan B. QUANTITATIVE TRILOBITE STUDIES III. PROLIOSTRACUS STRENUELLIFORMIS POULSEN, 1932: Jour. Paleontology, v. 33, no. 3, p. 474-87, 15 graphs, 3 tables, May 1959, 8 refs.

The measurements presented by Poulsen for 4 species of Proliostracus are compared statistically and graphically, and it is concluded that only one species is represented. The name Proliostracus strenuelliformis is selected, with the names P. rosenkrantzi, P. liostracoides, and P. noe-nygaardi suppressed as synonyms. The meaning of the regression equations is discussed for each pair of dimensions. --Auth.

1-1431. Branson, Carl C. PERMIAN SEA-SCORPION FROM OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 5, p. 111-12, May 1959, 5 refs.

The Permian eurypterid described by C. E. Decker in 1938 as Eurypterus oklahomensis is now regarded to be synonymous with Adelophthalmus selardsi Dunbar, 1924. The Oklahoma specimen was collected from the Wellington formation 1 1/2 mi. SE. of Red Rock, Noble County. --M. Russell.

1-1432. Olsen, Stanley J. THE BACULUM OF THE MIOCENE CARNIVORE AMPHICYON: Jour. Paleontology, v. 33, no. 3, p. 449-50, pl., May 1959, 2 refs.

A complete baculum of Amphicyon is figured and compared with similar elements found in Ursus and Canis. --Auth.

1-1433. Olsen, Stanley J. THE MIDDLE EAR OF THE MIOCENE MUSTELID LEPTARCTUS: Jour. Paleontology, v. 33, no. 3, p. 451-52, pl., May 1959, 4 refs.

A figured description of the middle ear of the mustelid Leptarctus ancipidens from the Florida Miocene. This form is compared with the badger Taxidea taxus, the closest living related form. --Auth.

1-1434. Howe, Henry V. FIFTY YEARS OF MICROPALEONTOLOGY: Jour. Paleontology, vol. 33, no. 3, p. 511-17, May 1959, 45 refs.

For mainly economic or practical reasons the bulk of micropaleontologic effort has been in the study of Foraminifera and Ostracoda. Given impetus by the ease with which micropaleontologic studies assist in oil exploration, many fossil Foraminifera were described and systems of classification erected by J. A. Cushman, F. Chapman, and M. Glaessner. To a lesser but still significant extent ostracods have been used in oil exploration, and their usefulness is increasing as detailed studies and refinements in classification are made. Other organisms which have been used to a minor extent include Radiolaria, Heliozoa, Chitinozoa, Holothurian sclerites, conodonts, and echinoid fragments. Major problems are the increasing complexities of foraminiferal and ostracod nomenclature, and keeping up with steadily increasing literature. Work done by Russian micropaleontologists has resulted in their language becoming the most important foreign language in the field. --M. Russell.

1-1435. McLean, James D., Jr., ed. MANUAL OF MICROPALEONTOLOGICAL TECHNIQUES: 152 p., Alexandria, Virginia, McLean Paleontological Laboratory, 1959.

Original and reprinted articles on techniques, in loose-leaf format for insertion of supplements as published by the laboratory. A source reference for micropaleontological laboratories and research laboratories wanting access to methods of staining, photomicrography, sectioning, etc. Edition is limited to 150 copies. Supplements will be issued at irregular intervals.--Auth.

1-1436. Glaessner, Martin F., and Mary Wade. REVISION OF THE FORAMINIFERAL FAMILY VICTORIELLIDAE: Micropaleontology, v. 5, no. 2, p. 193-212, 6 figs., 3 pls., table, Apr. 1959, 44 refs.

Victoriella "plecte" (Chapman) is synonymous with "Carpenteria" conoidea Rutten. "Rhynchospira" abnormis Hantken also belongs to Victoriella. The Carpenteria rotaliformis species-group indicates relationship of Carpenteria to Victoriella and Eorupertia. These genera, together with the new late Eocene pseudoplanispiral genus Maslinella, make up the Victoriellidae; Hofkerina is excluded. They show bilamellid wall structure, as described by Reiss. The family originated with Eorupertia (Eocene). Victoriella is rare in the late Eocene and widespread in the Oligocene to Aquitanian. --Auth.

1-1437. McGlasson, Robert H. FORAMINIFERAL BIOFACIES AROUND SANTA CATALINA ISLAND, CALIFORNIA: Micropaleontology, v. 5, no. 2, p. 217-40, 18 figs. incl. maps, 8 tables, Apr. 1959, 45 refs; also pub. as: Los Angeles, Univ. Southern California, Allan Hancock Found. Sci. Research, Contr. no. 238.

A study of the foraminiferal content of samples from around Santa Catalina Island, California, reveals that the living and dead foraminifera can be divided into 3 depth zones, ranging from 0 to 20 fathoms, from 21 to 40 fathoms, and from 41 to more than 100 fathoms. Among the factors studied by the author, either temperature or depth or a combination of both is primarily responsible for this bathymetric distribution. Sedimentation and submarine topography were found to be important in the distribution of foraminifera in smaller areas. --Auth.

1-1438. Levinson, Stuart A. BIBLIOGRAPHY AND INDEX TO NEW GENERA AND SPECIES OF OSTRACODA FOR 1957: Micropaleontology, v. 5, no. 2, p. 241-60, 3 graphs, Apr. 1959.

During 1957, 69 papers pertaining to Ostracoda were published, so far as now known. They contain descriptions of 73 new genera and 388 new species. The new forms range in age from lower Paleozoic to Recent. --Auth.

1-1439. Just, Theodor. PROGRESS IN PALEOBOTANY, 1908-1958: Jour. Paleontology, vol. 33, no. 3, p. 500-510, May 1959, approx. 200 refs.

The last 50 years represent the most productive period in the history of paleobotany, as is evident from many external and internal signs of progress. Among these are the growing number of active paleobotanists, the acquisition and establishment of more paleobotanical collections, the ever increasing number of published papers, catalogues, and books, and the more and more effective application of fossil plant materials for stratigraphic purposes and dating. Refined techniques, discoveries of new and highly productive localities, representative of nearly all fossiliferous ages and of widely separated geographic areas, and the introduction of many new viewpoints and concepts have greatly expanded the horizon and depth of paleobotanical research.

Integration of the results of related fields has materially advanced our understanding of fossil plants, their structure, mode of life, distribution, and evolution. The greatest advances have so far been made in regard to our knowledge of pteridophytes (ferns and fern allies) and gymnosperms (cycads, ginkgos, conifers, etc.). Intensive study of structurally preserved fossil material (wood, pollen, epidermis) of flowering plants (angiosperms) in addition to impression material is likely to result in many important and highly significant correlations

and interpretations, especially of Mesozoic and Tertiary strata. Experimental studies in the newly established discipline of paleobiochemistry promise to yield even more spectacular results in regard to such elusive problems as the origin of life, the appearance of photosynthesis, and the nature and sequence of appearance of other basic biological processes. --Auth.

1-1440. Cookson, Isabel C., and Mary E. Dettman. ON SCHIZOSPORIS, A NEW FORM GENUS FROM AUSTRALIAN CRETACEOUS DEPOSITS: Micropaleontology, v. 5, no. 2, p. 213-16, pl., Apr. 1959, 6 refs.

Four species of a new fossil microspore genus are described. Their resemblance to certain extra-Australian fossil and living microspores is noted. --Auth.

1-1441. Rásky, Klara. THE FOSSIL FLORA OF IPOLYTARNÓC (PRELIMINARY REPORT): Jour. Paleontology, v. 33, no. 3, p. 453-61, 2 pls., May 1959, 18 refs.

Leaf and fruit remains from the upper level of a sandstone showing high glauconite content and from the rhyolitic tuff lying immediately upon it, found in Ipolytarnóc (northern Hungary) are described. There are 10 new species and a new combination: Lobaria jablonszkyi, Anacolosa protofrutescens, Kadsura protowightiana, Magnoliaestrobus hungaricus, Scolopia protoluzonensis, Scheffera gaudini n. comb., Schefflera protomicrophylla, Schefflera protolucescens, Schefflera protomulticaulis, Antholithes araliaeformis, Tricalysia protojavanica. The recent relatives of the fossil plants described live in the mountain regions of southeastern Asia, scattered in rain forests. It is probable that the plants which lived in Ipolytarnóc required a similarly high humidity and warm temperature. As it may be inferred from investigations embracing the whole fossil flora of Ipolytarnóc, its age is upper Oligocene. --Auth.

1-1442. Lochman-Balk, Christina, and Chung-Hung Hu. A PTYCHASPIS FAUNULE FROM THE BEAR RIVER RANGE, SOUTHEASTERN IDAHO: Jour. Paleontology, v. 33, no. 3, p. 404-427, fig., 4 pls., May 1959, 29 refs.

Faunules of the Ptychaspis subzone of the Franconian stage appear to be widespread in southeastern Idaho and eastern Utah, but have not previously been described. The trilobite coquina limestone furnishing this collection is from the St. Charles limestone, 250 ft. to 273 ft. above the top of the Worm Creek quartzite member, on the ridge N. of Mink Creek, Idaho. Ten genera and 14 species of trilobites, 2 genera and species of gastropods, 3 genera of brachiopods, Hyolithes, sponge spicules, and cystoid fragments comprise the assemblage. The new species, Ptychaspis bullasa, Idahoia (Meeria) modesta, Saratogia fria, Bellaspis? oblonga, Taenicephalina globula, Anconochilus idahoensis, and the new genus Minkella americana, are described. In the population of the latter species probable male and female forms are indicated.

The faunule is placed at or near the top of the Ptychaspis granulosa teilzone. The appearance of Taenicephalina, Bellaspis, Minkella, a member of the Dokimocephalidae, and 2 species of Pseudagnostus occurring also in eastern Nevada shows the first interminglings of far western or extracratonic faunal elements with a characteristic shallow shelf assemblage, a phenomenon fully compatible with the geographic position of the collection. --Auth.

1-1443. Newell, Norman D., John Imbrie, Edward G. Purdy, and David L. Thurber. ORGANISM COMMUNITIES AND BOTTOM FACIES, GREAT BAHAMA BANK: Am. Mus. Nat. History, Bull., v. 117, art. 4, p. 177-228, figs. 1-17, pls. 58-69, fold. map of Bimini-Cat Cay area, tables 1-6, June 8, 1959, 58 refs.

Systematic sampling and mapping of living marine bottom communities and sediment facies of the northwestern part of the Great Bahama Bank yield significant data for the interpretation of ancient limestones. Five principal sediment facies are delineated on the basis of reconnaissance mapping: muddy sand and mud, pellet sand, grapestone sand, unstable oölite, and mixed skeletal sand. Rock-bottom habitats support 4 distinct communities: the littorine community (rocky shore), the Millepora community (infratidal rock ledges and prominences), the Acropora palmata community (coral reefs), and the plexaurid or seawhip community (rock pavement). Sediment bottoms support 5 distinct communities: the Strombus samba community (unstable sand of the outer platform), the Tivela community (unstable oölite sand), the Strombus costatus community (stable sand), the Didemnum community (offshore areas of muddy sand), and the Cerithidea community (nearshore, poikilohaline mud bottoms). The character and distribution of the communities are closely correlated with substrate character. The interpretation is made that both organisms and bottom facies are controlled chiefly by regimens of waves and currents. --Auth.

6. GEOPHYSICS

See also: Structural Geology 1-1376; Mineralogy 1-1471; Geohydrology 1-1526, 1-1527.

1-1444. Keller, G. V., and P. H. Licastro. DIELECTRIC CONSTANT AND ELECTRICAL RESISTIVITY OF NATURAL-STATE CORES: U. S. Geol. Survey, Bull. 1052-H, p. 257-85, 21 illus., 2 tables, May 1959, 24 refs.

As part of a program to obtain basic data on the physical properties of the rock in and near U-mineralized zones, measurements of electrical resistivity and dielectric constant were made on parts of 27 cores from the Morrison formation in the Colorado Plateau U province. For frequencies between 50 cycles and 30 megacycles per second, resistivity ranged from 10^2 to 10^{12} ohm-centimeters, and the dielectric constant ranged from 4.0 to more than 10^6. The water content of the cores seemed to be the controlling factor; the high resistivity was associated with low water content and the high dielectric constants with high water content. --Auth.

1-1445. Press, Frank. SOME IMPLICATIONS ON MANTLE AND CRUSTAL STRUCTURE FROM G WAVES AND LOVE WAVES: Jour. Geophys. Research, v. 64, no. 5, p. 565-68, 2 figs., 2

tables, May 1959, 9 refs.; also pub. as: California Inst. Technology, Div. Geol. Sci., Contr. no. 919.

G-wave velocities for continental and oceanic paths do not differ by more than about 2%. Since the G-wave velocity is controlled by the low velocity zone in the mantle, this zone is present beneath continents and oceans. This suggests that the composition and distribution of temperature are the same for depths greater than about 50 km. under continents and oceans. The low velocity zones may be the source of the primary basaltic magma and could account for the long-period nature of S waves. It may also represent a zone of decoupling for relative movements between crust and mantle.

Love waves with long propagation paths recorded with long period seismographs are used to infer that the mean value of continental crustal thickness lies in the range of 32 to 37 km. --Auth.

1-1446. Fobes, Charles B. MAINE EARTHQUAKES - A SUMMARY, 1927-1957: Maine Field Naturalist, v. 14, no. 2, p. 30-36, Apr. 1958, 4 refs.

A list of the earthquakes reported in Maine has been compiled, giving their location, date, time, and intensity according to the Modified Mercalli Intensity Scale of 1931. This compilation is a continuation of one prepared by Edward H. Perkins in The Maine Naturalist, v. 8, no. 4, p. 147-53, Dec. 1928. Epicenters of the most severe earthquakes are given. --Auth.

1-1447. Tixier, Maurice Pierre, R. P. Alger, and C. A. Doh. SONIC LOGGING: Jour. Petroleum Technology, v. 11, no. 5, p. 106-114, 23 figs., 4 tables, May 1959, 9 refs.

The principle, the equipment, and field operation of sonic logging are described. The 2-receiver system produces logs independent of hole size and mud. Field experience is given and forms the basis for the interpretation of the log. The derivation of porosity values from measured velocities is discussed, according to the type of formations (hard formations, compacted sands, and unconsolidated formations). The time-average equation proposed by M. R. J. Wyllie, A. R. Gregory and L. W. Gardner is used as a basis for the computation of porosity in limestones,cemented sandstones and compacted sands. Variations in the lithologic character of limestones do not seem to change the porosity calibration markedly. The compaction of sands is related to the compaction of shale adjacent to them; and, thus, the shale velocity is used for the establishment of empirical relations for the computation of porosity in unconsolidated formations. Various formulas are tentatively presented to account for shale and fluid content.

Field experience demonstrates that considerable attenuation of sonic energy takes place in unconsolidated formations, particularly when gas bearing, and in fractured formations. Unusually large attenuation produces skipped cycles, a feature easily recognized. The application of sonic logging to structural studies is featured, showing its possible integration with the dipmeter. Correlation and its application to the interpretation of seismic surveys are reviewed.

The paper is illustrated with field examples. --Auth.

1-1448. Garland, G. D., and R. A. Burwash. GEOPHYSICAL AND PETROLOGICAL STUDY OF PRECAMBRIAN OF CENTRAL ALBERTA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 790-806, 6 figs. incl. 2 maps, Apr. 1959, 8 refs.

It is shown that the major part of the Bouguer gravity anomaly field over central Alberta must be attributed to lithological changes in the Precambrian basement beneath the sedimentary section. By making use of the petrology and physical properties of samples from wells that have reached the Precambrian, in conjunction with the gravity data, a lithological map of the basement has been produced. The covered shield can be traced to the region beneath the Rocky Mountains, at least as far W. as Banff. Depth estimates made from gravity profiles strongly suggest that the Precambrian has been uplifted beneath the mountains. --Auth.

1-1449. Joesting, Henry R., and P. Edward Byerly. REGIONAL GEOPHYSICAL INVESTIGATIONS OF THE URAVAN AREA, COLORADO: U. S. Geol. Survey, Prof. Paper 316-A, 17 p., 8 illus. (3 in pocket); geol. map scale 1:125,000, Bouguer gravity anomaly map scale 1:125,000, aeromagnetic map scale 1:125,000, May 1959, 24 refs.

Aeromagnetic and regional gravity surveys have been conducted in the Uravan area as part of a study of the regional geology of the Colorado Plateau. Interpretations are based on available surface and subsurface geologic information and on geophysical data.

The Uravan area is in the E.-central part of the Colorado plateau physiographic province, and except for the Uncompahgre Plateau which bounds the NE. side, it lies within the Paradox salt basin, a sedimentary basin of Pennsylvanian age in SW. Colorado and SE. Utah.

Exposed rocks in the area include crystalline rocks of Precambrian age in the Uncompahgre Plateau, sedimentary rocks that range in age from Pennsylvanian to Quaternary, and a few small intrusions of diorite of probable Tertiary age. Devonian and Mississippian rocks have been penetrated in wells drilled in the area, and rocks of Cambrian age have been penetrated in adjoining areas and probably occur in the Uravan area. The rocks of latest Paleozoic and earliest Mesozoic age wedge out against the Precambrian rocks of the Uncompahgre Plateau, but the younger Mesozoic strata extend across the uplifted basement complex.

Structurally, the Uravan area is characterized by a major faulted monocline which bounds the Uncompahgre Plateau on the SW., by great salt piercement anticlines, and by gently dipping strata between the larger features. The major structural features strike NW.

The larger magnetic anomalies are related to changes in the magnetization and probably in the composition of the basement rocks and to faults involving large displacements of the basement. Prominent anomalies along the flank of the Uncompahgre uplift are associated with a belt of magnetic rocks which apparently occur in large fault blocks. Similar though less intense anomalies along Disappointment syncline suggest an uplift that marks the SW. margin of a basement trough parallel to the Uncompahgre Plateau.

The major gravity anomalies are related to variations in the thickness of salt deposits in the Paradox member of the Hermosa formation and to differences in the density of the basement rocks. Large negative anomalies, associated with the Paradox Valley and Gypsum Valley salt piercement anticlines, suggest that the section between the valleys from the top of

the Chinle formation down to the salt of the Paradox is about 8,500 to 10,000 ft. thick. There is no definite evidence of an appreciable thickness of undistributed salt near the flanks of the piercement anticlines, but the basement anomalies could obscure the effects of the salt. If there is no salt, then the thickness of the section is about 10,000 ft. Gravity gradients indicate that, except locally, basement relief is gradual along the Uncompahgre front, perhaps because the major fault scarps have been reduced by erosion. NE. of Nucla, however, there is evidence of a large fault scarp.

Magnetic and gravity trends are generally parallel to the northwestward-trending regional structural features. S. of Uravan, however, the regional gravity trend is normal to the present structural trend, probably because of rocks of high density within the basement. --Auth.

7. GEOCHEMISTRY

See also: Stratigraphy 1-1408, 1-1409, 1-1410; Mineralogy 1-1474, 1-1478, 1-1480, 1-1481, 1-1485, 1-1489, 1-1496, 1-1500, 1-1501, 1-1502; Sedimentary Petrology 1-1511 through 1-1515; Mineral Deposits 1-1536, 1-1537.

1-1450. Schmalz, Robert F. A NOTE ON THE SYSTEM Fe_2O_3-H_2O: Jour. Geophys. Research, v. 64, no. 5, p. 575-79, 4 figs., table, May 1959, 4 refs.

Hydrothermal investigation of a portion of the system Fe_2O_3-H_2O has served to locate approximately the hematite-goethite phase boundary. Calculations derived from the experimental data provide the following estimates of the thermodynamic properties of goethite at 25°C.: ΔH_f = -132 K cal./mol.; S^o = +18.1 cal./mol.-degree; ΔS_f = -51.0 cal./mol.-degree; ΔG_f = -117 K cal./mol. Goethite is shown to be the stable ferric oxide phase under sub-aerial weathering conditions where relative humidity exceeds 60%. Goethite is also shown to be stable in all normal marine environments, though hematite may become stable in contact with saline liquors of an evaporite basin. --Auth.

1-1451. Creasey, S. C. SOME PHASE RELATIONS IN THE HYDROTHERMALLY ALTERED ROCKS OF PORPHYRY COPPER DEPOSITS: Econ. Geology, v. 54, no. 3, p. 351-73, 11 diags., chart, 3 tables, May 1959, 23 refs.

The application of ACF and AKF diagrams to the hydrothermal alteration in porphyry Cu deposits aids in the recognition of the critical components, and the characteristic mineral phases permit the distinction of one alteration facies from another.

The somewhat meager chemical and mineralogical data suggest 3 principal alteration facies, herein called the propylitic, argillic, and potassium silicate facies. The ACF diagram applies to the propylitic alteration. The critical components are Al_2O_3, CaO, and (FeO + MgO + MnO), and the characteristic minerals are muscovite (sericite), epidote, chlorite, and a member of the carbonate group. The AKF diagram applies to the argillic and potassium silicate facies. The critical components are Al_2O_3, K_2O, and (FeO + MgO + MnO). The characteristic minerals for the argillic facies are kaolinite (or other member of the group) and muscovite (sericite); and for the potassium silicate facies, muscovite (sericite), biotite, and K-feldspar.

For the propylitic facies, insufficient chemical analyses are available to show the chemical changes between the fresh and altered rock. For the argillic and potassium silicate facies, chemical analyses indicate a loss in Al, Fe, Mg, Ca, and Na; and a gain in K, hydroxyl ion (water), and S. The gain in K is about 60% greater for the potassium silicate facies than for the argillic. --Auth.

1-1452. Ellis, A. J. THE SOLUBILITY OF CALCITE IN CARBON DIOXIDE SOLUTIONS: Am. Jour. Sci., v. 257, no. 5, p. 354-65, 8 tables, May 1959, 13 refs.

The solubility of calcite in water is reported for temperatures between 100 and 300°, at partial pressures of carbon dioxide ranging from 1-40 atmospheres. Values for the solubility product and the free energy of solution of calcite are derived.

From a study of the kinetics of solution of a single calcite crystal at these temperatures the Arrhenius energy of activation was found to be very low. The rate determining step is suggested to be a diffusion or desorption process. --Auth.

1-1453. Pettersson, Hans. RATE OF ACCRETION OF COSMIC DUST ON THE EARTH: Hawaii, Univ., Inst. Geophysics, Contr. no. 5, 1 p., 1958, 3 refs.; reprinted from: Nature, London, v. 181, p. 330, Feb. 1, 1958.

Cosmic dust in the air at 10,000- and 11,000-ft. levels over Hawaii was measured. Ni content and Fe content was 14.3 and 1,577 micrograms per thousand cubic meters of air respectively. The amount of cosmic dust in the lower 100 km. of the atmosphere is calculated to be 28.6 million tons. Half that amount, 14.3 million tons, falls to earth each year. --M. Russell.

1-1454. Bate, George L., John R. Huizenga, and Herbert August Potratz. THORIUM IN STONE METEORITES BY NEUTRON ACTIVATION ANALYSIS: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 88-100, fig., table, May 1959, 12 refs.

Radiochemical procedures for assay of Pa^{233} following neutron activation of Th^{232} in stone meteorites are described in detail. Eight analysis of 5 chondrites yielded an average concentration of $(3.96 \pm 0.20) \times 10^{-8}$ g Th/g. which, with proper assumptions, leads to a cosmic atomic abundance of 0.026 for Th (per 10^6 Si atoms). The Th concentrations in 2 achondrites were found to differ by nearly 2 orders of magnitude. On comparison with U concentrations in stones determined by neutron activation analysis, the Th/U ratio in chondrites and achondrites agrees to nearly 5%, yielding an average weight ratio of about 3.6. --Auth.

1-1455. Poldervaart, Arie, and Jack Green. ABUNDANCE OF MAJOR ELEMENTS IN THE EARTH'S CRUST [AGI Data Sheet 12]: GeoTimes, v. 3, no. 8, p. 25-27, May-June 1959, refs.

The distribution of Si, Ti, Al, Fe^{+3}, Fe^{+2}, Mn, Mg, Ca, Na, K, P, C, Cr, and S in 70 components of the earth's crust is compiled from many sources

and presented as a field notebook reference sheet. Detailed references for the data sheet are listed. --M. Russell.

1-1456. Jizba, Z. V. FREQUENCY DISTRIBUTION OF ELEMENTS IN ROCKS: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 79-82, May 1959, 11 refs.

Two models are suggested as possible mechanisms to generate frequency distribution of elements in nature. One model leads to a 3-parameter β-distribution. The second model leads to a distribution which approaches lognormality for trace elements. --Auth.

1-1457. Burton, J. D., F. Culkin, and J. P. Riley. THE ABUNDANCES OF GALLIUM AND GERMANIUM IN TERRESTRIAL MATERIALS: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 151-80, 29 tables, May 1959, 50 refs.

A sensitive spectrophotometric method using phenylfluorone has been applied to the determination of Ge in over 200 minerals, rocks, and sediments and in sea water. The crustal abundance of Ge is about 1·7 p. p. m., which is the mean Ge content of both granitic and basic igneous rocks. The average amounts of Ge in metamorphic rocks, shales, and red clays lie close to this value. The Ge content of pelagic sediments is contained entirely in their clay fraction. Of the minerals examined, sulphates, carbonates, and evaporite minerals contained only very low concentrations of the element. Most oxides and silicates have Ge contents close to the mean crustal abundance. The average concentrations of Ge in magmatic sulphides is less than 1 p. p. m. Sea water has been found to contain $0{\cdot}06 \pm 0{\cdot}01$ μg. Ge/kg. ($0{\cdot}82 \pm 0{\cdot}13$ μg.-atom/ton).

Ga has been determined in sea water and in over 280 minerals, rocks, and sediments, using a sensitive and specific spectrophotometric method. The average crustal abundance of the element is 16·9 p. p. m. The Ga content of over 80% of the 33 granitic rocks examined lay between 14 and 24 p. p. m. (average 18·1 p. p. m.). The average Ga:Al ratio for such rocks is $2{\cdot}35 \times 10^{-4}$. The mean Ga concentration found for 20 siliceous sediments is 9·9 p. p. m.; in general, residual sandstones and other sedimentary rocks rich in silica are poor in Ga. Hydrolysate sediments such as clays and mudstones are similar to granitic rocks in Ga content. Only traces of Ga are found in carbonate rocks (mean 0·06 p. p. m.). Pelagic clays from the Pacific, Atlantic, and Indian Oceans contained an average of 22·4 p. p. m. of the element and had a Ga:Al ratio of $2{\cdot}40 \times 10^{-4}$. Most of the Ga present in the other pelagic sediments is contained in their clay fraction. The element is enriched relative to Al in Mn nodules (mean Ga:Al = $9{\cdot}7 \times 10^{-4}$).

The only oxide minerals examined which contain noteworthy amounts of Ga are corundum, bauxite, and magnetite. With the exception of blende formed at low temperature, all the sulphides investigated contained less than 3 p. p. m. of the element. Carbonate, sulphate, fluoride, and evaporite minerals generally had not more than 0·15 p. p. m. Ga is concentrated in feldspars of pegmatite origin and in the late crystallizates, such as micas. Sea water contains $0{\cdot}030 \pm 0{\cdot}007$ μ g. of Ga/kg. ($0{\cdot}44 \pm 0{\cdot}10$ μ g. atom/ton) and has a Ga:Al ratio of about $3{\cdot}0 \times 10^{-3}$. --Auth.

1-1458. Sen, N., S. R. Nockolds, and R. Allen. TRACE ELEMENTS IN MINERALS FROM ROCKS OF THE S. CALIFORNIAN BATHOLITH: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 58-78, 2 figs., 16 tables, May 1959, 9 refs.

In general, each mineral series studied is behaving as one might expect on the assumption that the rocks whose elements fall on smooth curves in the variation diagrams belong to a liquid line of descent controlled largely by process of crystallization-differentiation but modified to some extent, as in the case of the Green Valley tonalite, by assimilation of earlier gabbroic material. The early gabbroic rocks of the batholith mostly lie off the supposed liquid line of descent and are believed to represent accumulative types. The composition of the members of the various mineral series from such rocks supports this view.

Such assumptions would be in harmony with the views expressed by Larsen (1948): "It is therefore concluded that the differentiation was due to crystal settling modified by assimilation." More recently, Chayes (1956) has expressed the view that the intermediate types in the batholith are all hybrids between a quartz-free gabbro and a granodiorite devoid of hornblende, pyroxene, and ores. This could well be the case for intermediate rocks such as the Green Valley tonalite, but seems less likely to be the whole story for those like the Bonsall tonalite. --Auth. summ.

1-1459. Murata, K. J., C. V. Dutra, M. Teixeira da Costa, and J. J. R. Branco. COMPOSITION OF MONAZITES FROM PEGMATITES IN EASTERN MINAS GERAIS, BRAZIL: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 1-14, 5 figs. incl. index map, sec., 3 tables, May 1959, 28 refs.

Two zoned pegmatites in southeastern Minas Gerais were sampled in detail for their content of monazite and xenotime, and the monazite was analysed for certain of the rare-earth elements and Th.

The ratio of xenotime to monazite increases in both pegmatites from the wall toward the quartz core. The content of the less basic rare-earth elements and of Th in monazite rises in the same direction. These variation trends suggest that during the crystallization of these pegmatites there was a fractionation of the elements leading to a more or less steady enrichment of the less basic rare-earth elements and of Th in the residual fluids. One mode of explaining these observed effects postulates that the rare-earth elements and Th were present in pegmatitic fluids as co-ordination complexes rather than as simple cations. --Auth.

1-1460. Wilkinson, J. F. G. THE GEOCHEMISTRY OF A DIFFERENTIATED TESCHENITE SILL NEAR GUNNEDAH, NEW SOUTH WALES: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 123-50, 2 figs., 9 tables, May 1959, 38 refs.

Data for the commoner trace elements in the rock and component mineral series of a differentiated teschenite sill are presented. The most important trace elements in the various mineral series are: olivines, Ni, Co; clinopyroxenes, Cr, Ni, Co, V, Zr, Sc, Sr; titanomagnetites, Ga, Cr, Ni, Co, V; plagioclase feldspars, Ga, Sr, Ba; analcites, Ga, Zr, Ba, Rb. With differentiation Cr, Ni, Co, and V reveal the most extreme variation, both in the rock and mineral series; these elements are absent in a vein of microcrystalline mesostasis (approximating in its composition to analcite syenite) from the uppermost levels of the sill. Zr, Ba, and Rb are enriched in

this liquid. Fractionation crystallization is considered to have been the differentiation mechanism responsible for the variations in the rock and mineral series. --Auth.

1-1461. Belin, R. E. RADON IN THE NEW ZEALAND GEOTHERMAL REGIONS: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 181-91, 2 figs., 5 tables, May 1959, 18 refs.

Measurements have been made on Rn and thoron associated with gas and condensate samples from fumaroles and pools, situated along the Rotorua-Taupo graben. Methods of collection and measurement are briefly described.

The values of Rn to gas (R_g) range from $0{\cdot}8 \times 10^{-9}$ to 320×10^{-9} curies/liter (c/l.) for pools and $0{\cdot}32 \times 10^{-9}$ to 340×10^{-9} c/l. for fumaroles. Rn to condensate values (R_c) for fumaroles fall in the range of 7×10^{-9} to 340×10^{-9} c/l. of condensate.

Variations in discharges of Rn and thoron have been related to geology, i.e. there is a greater radioactive discharge from acid igneous regions than from intermediate igneous regions. The ratio of the average of the R_c-values for fumaroles in the acid igneous regions to the average of the R_c-values for fumaroles in the intermediate igneous regions is equal, within experimental error, to the ratio of the γ-counting rates of the surface rocks of the 2 regions. It is therefore suggested that it is steam or water which is responsible for bringing the radioactive gases to the earth's surface. --Auth.

1-1462. Le Riche, H. H. THE DISTRIBUTION OF CERTAIN TRACE ELEMENTS IN THE LOWER LIAS OF SOUTHERN ENGLAND: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 101-122, 8 figs., 8 tables, May 1959, 30 refs.

The apparent rarity of the conditions which give rise to the teart disease of cattle in central Somerset has led to a study of the distribution of Mo in the Lower Lias shales from which the teart soils are derived.

Analyses of numerous specimens of shale from 2 boreholes and from outcrops on the coasts of Dorset and Glamorgan have shown considerable variation to occur over the formation, but correlations have been found between the concentrations of Mo, V, Cu, and Ni. The amounts of these elements in the shales are related to the organic C content, and these together are related to the percentage of calcium carbonate, reaching a maximum with 20-50% $CaCO_3$.

Detailed study of one shale specimen has shown that despite the correlation of these elements with organic C, they are not all associated with it. Some of the Mo is associated with the silicates and pyrite, while nearly all the V resides in the silicates. Cu and Ni appear to be mainly organically bound, although some of the latter is in exchangeable form. --Auth.

1-1463. Graham, John W. METABOLICALLY INDUCED PRECIPITATION OF TRACE ELEMENTS FROM SEA WATER: Science, v. 129, no. 3360, p. 1428-29, May 22, 1959, 7 refs.; also pub. as: Woods Hole, Mass., Oceanog. Inst., Contr. no. 1011.

The presence of organic material in some Mn-rich nodules suggests that the nodules are of biological origin. This suggestion leads to the proposal that in sea water, heavy metals get protection from hydrolysis by organic complexing; parts of these complexes become metabolized, the remaining parts then precipitate. These processes would explain a number of interesting observations. --Auth.

1-1464. Burwell, Albert L. GYPSUM AS AN OXIDIZING AGENT: Oklahoma Geology Notes, v. 19, no. 5, p. 107-108, May 1959.

In the presence of an oxidizable material and high temperature, gypsum dissociates:

$$CaSO_4 \cdot 2H_2O \rightarrow CaO + 2H_2O + SO_2 + O$$

which oxygen can be consumed by the oxidizable material, as for example pyrite:

$$2FeS_2 + 2O \rightarrow Fe_2S_3 + SO_2$$

Economic applications are in the manufacture of glass and portland cement. --M. Russell.

1-1465. Broecker, Wallace S., and A. Walton. THE GEOCHEMISTRY OF C^{14} IN THE FRESH WATER SYSTEMS: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 15-38, 3 figs. incl. 2 index maps, 7 tables, May 1959, 15 refs.

The processes controlling the radiocarbon concentration in the dissolved bicarbonate of fresh water systems have been investigated in order to allow more precise estimates to be made of the initial C^{14}/C^{12} ratio in materials formed in such systems in the past. Two factors control this ratio: (a) the relative amounts of silicate and carbonate minerals dissolved by the system and (b) the rate of exchange of CO_2 across the water-air interface.

Measurements on samples collected from the Great Basin yield information on both of these factors. As would be expected, the initial C^{14}/C^{12} ratio of the bicarbonate in streams flowing over igneous rocks is close to that in atmospheric CO_2. The CO_2 exchange rates across the surfaces of Mono, Walker, Pyramid, and Great Salt lakes are similar. The results suggest that the exchange rate for lakes is within the range of from 2 to 15 moles/m^2 per year. These values are consistent with published estimates for the average exchange rate for the oceans.

Whereas these data allow the C^{14}/C^{12} ratio in samples formed in ancient lake Lahonton to be estimated within $\pm$ 5%, the error for random fresh water samples is probably as great as $\pm$ 20%.

Thus it appears that whereas considerable uncertainty must be attached to radiocarbon ages on random fresh water materials, where detailed studies such as the above are made the uncertainty can be reduced to the level of the laboratory error. --Auth.

1-1466. Clayton, Robert N., and Egon T. Degens. USE OF CARBON ISOTOPE ANALYSES OF CARBONATES FOR DIFFERENTIATING FRESH-WATER AND MARINE SEDIMENTS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 890-97, 3 tables, Apr. 1959, 21 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 57-47.

The environmental interpretation of sedimentary rocks is one of the principal objectives of the sedimentologist and stratigrapher. In the past, such interpretations have been based primarily on certain

diagnostic fossils and the gross petrography, criteria which have obvious limitations. In recent studies, Degens et. al. have shown that geochemical criteria can be successfully used as environmental indicators for most sedimentary rock types.

The purpose of this investigation is to study the application of stable isotope abundance measurements as possible environmental indicators. C and O isotope analyses of the carbonate fraction were made on samples of limestone, sandstone, shales, and some fossil shells. The majority of the samples were collected from the Allegheny series of Clearfield County [Pennsylvania] and have been classified into fresh-water and marine groups in previous investigations. The remainder of the samples were collected from different formations and localities and have been classified into marine and fresh-water groups on the basis of fossils. --Auth. introd.

1-1467. Jensen, M. L. SULFUR ISOTOPES AND HYDROTHERMAL MINERAL DEPOSITS: Econ. Geology, v. 54, no. 3, p. 374-94, chart, graph, table, May 1959, 29 refs.

In the past, hopeful attempts have been made to determine the type of mineral deposit (i. e., pegmatitic, magmatic, hydrothermal, and so forth) by means of S isotope ratios. The recognition of the overlap and similarity of S^{32}/S^{34} ratio values determined from specimens from such deposits is a clear indication that these ratios provide no simple panacea to the classification of mineral deposits.

On the other hand, however, S ratios of specimens from some hydrothermal deposits, although they do not exhibit identical values, do show a comparatively narrow spread, usually $< \pm 0.5\%$, in ratio values which is a striking contrast when compared to other hydrothermal deposits that contain sulfides that vary in ratio by as much as 4% and more.

The recognition that these rather similar hydrothermal deposits are dissimilar in degree of S isotopic homogeneity is quite striking when considered in relation to the known geology of the deposits.

In those deposits that are intimately associated with the intrusive body from which it is believed the ore solutions were derived, the spread in ratio values in very narrow, but those deposits that are not associated with an apparent magmatic source exhibit a broad spread in ratio values.

As a result, it is suggested that S isotope ratios may provide an additional aid or "tool" whereby the economic geologist may be better equipped to learn more about the different sources of hydrothermal solutions and obtain a better understanding about the processes by which hydrothermal mineral deposits have been formed.

It is suggested, furthermore, as an initial step, that hydrothermal deposits might be subdivided according to different ore fluid sources, or, at least, according to what may be believed to be the sources. Apparently, S isotope ratios do aid in providing some evidence for subdividing many hydrothermal deposits as Magmatic Hydrothermal deposits, Metamorphic Hydrothermal deposits, and Ground Water Hydrothermal deposits.

It is evident, therefore, that the use of the term hydrothermal in this paper includes those minerals formed by heated waters that are not at all necessarily magmatic in origin. It is believed that most students of ore genesis would not restrict the term to this sole source. --Auth.

1-1468. Stieff, L. R., T. W. Stern, Seiki Oshiro, and F. E. Senftle. TABLES FOR THE CALCULATION OF LEAD ISOTOPE AGES: U. S. Geol. Survey, Prof. Paper 334-A, 40 p., 2 illus., 4 tables, May 1959, 14 refs.

Tables are presented for calculating geologic age by using the atomic ratios of Pb^{206}/U^{238}, Pb^{207}/U^{235}, Pb^{207}/Pb^{206}, and Pb^{208}/Th^{232}.

Tables of values of N_d/N_p and t are given for the age equation

$$\frac{N_d}{N_p} = \exp \lambda t - 1$$

where λ is the decay constant,

t is age, in millions of years,

N_d is the number of atoms of daughter products, and N_p is the number of atoms of parent.

Values for N_{207}/N_{206} and t are also given in tabular form for the age equation

$$\frac{N_{207}}{N_{206}} = \frac{\exp \lambda_{235} t - 1}{k(\exp \lambda_{238} t - 1)}$$

where N_{207} and N_{206} are the number of atoms of radiogenic Pb^{207} and Pb^{206}, respectively, and where k, the present-day atomic ratio of U^{238} to U^{235}, is taken as 137.7. The half lives (T) of U^{238}, U^{235}, and Th^{232} used in the calculations are: $T_{238} = 4.51 \times 10^9$ years, $T_{235} = 7.13 \times 10^8$ years, $T_{232} = 1.42 \times 10^{10}$ years.

The tables cover selected values of t from 1 to 6,000 million years (6×10^9 years) at intervals of t ranging from 1 to 15 million years. Only the calculated errors in t resulting from experimental uncertainties in the determinations of the decay constants and relative abundance of U^{238} and U^{235} have been included. An example is given for a hypothetical geologic age calculation by use of these tables. --Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geochemistry 1-1452, 1-1459, 1-1464; Sedimentary Petrology 1-1518.

1-1469. Hewlett, C. G. OPTICAL PROPERTIES OF POTASSIC FELDSPARS: Geol. Soc. America, Bull., v. 70, no. 5, p. 511-38, 5 figs., 11 tables, May 1959, 50 refs.

Optical and X-ray studies of 15 chemically analyzed feldspars show that the optical properties of potassic feldspars may vary because of (1) compositional differences, such as degree of substitution of Fe^{3+} for Al and of Na, Ca, Ba, Sr, and Rb for K in the feldspar structure, with corresponding substitution of Al for Si where necessary to balance electrostatic charges, (2) presence on a submicroscopic scale of twinning or intergrowths of materials of different refractivities, such as unmixing of a plagioclase from a potassic host or partial inversion of orthoclase to microcline, and (3) degree of order in the distribution of Si and Al within the tetrahedral sites of the feldspar structure. The α refractive

index of homogeneous feldspars provides a measure of composition because it does not vary appreciably with Si/Al ordering. The substitution of Na for K, however, causes such a small index increase in the range $Or_{100}Ab_0$ to $Or_{60}Ab_{40}$ that its effects normally are masked by the larger increases due to substitution of minor amounts of Ca, Sr, Ba, and Fe. As a consequence refractive indices of alkali feldspars are not useful for determining chemical composition. The decrease in the α index when cryptoperthites are homogenized at 850° C. is a measure of the degree of unmixing. The optic angle 2V and the birefringence "b" - α provide a measure of the degree of Si/Al ordering, provided composition is known. In this paper "b" is defined as the refractive index of the ray vibrating parallel or nearly parallel to the b crystallographic direction. Most existing diagrams relating optical properties to composition of alkali feldspars are constructed for groups of feldspars with the same state of Si/Al ordering and do not emphasize the importance of degree of unmixing in determining refractive indices. These diagrams are valid only if the state of order varies sympathetically with the degree of unmixing. Zoning in some sanidines is attributed to variations in the concentration of divalent alkali ions or, possibly, of Fe^{3+}, and in other sanidines to variations in the degree of Si/Al ordering. --Auth.

1-1470. Angino, Ernest E., and Frederic R. Siegel. THE EFFECTS OF TRACE ELEMENTS ON NATURAL THERMOLUMINESCENCE: Compass, v. 36, no. 4, p. 296-303, 4 figs. incl. index map, graphs, May 1959, 8 refs.

The effects of Mg, Sr, and Fe, on natural thermoluminescence were investigated. Mg and Sr appeared to increase the area under the middle and high temperature thermoluminence peaks respectively. Conversely, Fe acted as an inhibitor and lowered the total thermoluminescence of the samples. Though the interpretations were based on 10 samples and cannot be accepted as definitive, the results observed do warrant further research. --Auth.

1-1471. Angino, Ernest E. PRESSURE EFFECTS ON THERMOLUMINESCENCE OF LIMESTONE RELATIVE TO GEOLOGIC AGE: Jour. Geophys. Research, v. 64, no. 5, p. 569-73, 3 figs., May 1959, 5 refs.

Thermoluminescence as modified by pressure has been studied, and a relationship between pressure effects and geologic age has been observed. Experimental evidence indicates that the amount of pressure and the length of time that it is applied cause a marked variation in the ratio of thermoluminescence of pressed to unpressed samples. Geologically young samples showed a greater variability in the induced time-pressure effects than did geologically older samples.

The ratio of thermoluminescence of pressed to unpressed samples plotted against the time the pressure was applied showed a systematic variation from low values through a pronounced maximum and back to intermediate values. The amplitude of this curve shows an inverse relationship to the geologic age of the sample for limestones younger than Mesozoic. --Auth.

1-1472. Muessig, Siegfried. PRIMARY BORATES IN PLAYA DEPOSITS: MINERALS OF HIGH HYDRATION: Econ. Geology, v. 54, no. 3, p. 495-501, May 1959, 28 refs.

The primary borate minerals in nonmarine bedded borate deposits - those of the playa type, and their deformed derivatives - are the high hydrates. Both field and laboratory data indicate that the high hydrates are the borate minerals that form stable phases at the lowest temperatures: under the surface conditions of playas.

From a study of hand specimens of borate minerals from the new Turkish borate deposits, Meixner suggested that the borate minerals having the lowest specific gravity, and hence, highest water content, are the primary minerals.

The role of temperature in the formation of the hydrous borates is shown by solid phases in the system $Na_2B_4O_7$-H_2O. As temperature increases, hydration of the solid phase decreases successively from borax ($10H_2O$) through tincalconite ($5H_2O$), kernite ($4H_2O$), to metakernite ($2H_2O$). This suggests that in the temperature ranges considered in the present paper - those of playas - the high hydrate (borax) is the one most likely to form as the primary mineral in nature. Studies of the Ca, Mg, and Ca-Na hydrous borate systems suggest that the same statement holds in these systems.

Until recently, only borax and ulexite ($Na_2O \cdot 2CaO \cdot 5B_2O_3 \cdot 16H_2O$) have been known as primary minerals of playa deposits. However, inderite ($2MgO \cdot 3B_2O_3 \cdot 15H_2O$) has recently been found as a primary mineral in Argentina and primary inyoite ($2CaO \cdot 3B_2O_3 \cdot 13H_2O$) has been found in Peru. These 4 minerals are the high hydrates of their respective mineral series. None of the lower hydrates are known as primary minerals in nonmarine bedded deposits.

On burial and deformation of the primary minerals, the changes in temperatures and pressures are almost certainly in such a direction as to encourage minerals of higher density and lower hydration to become stable phases. Field evidence bears this out; in all deformed deposits secondary minerals of low hydration are quantitatively important. --Auth.

1-1473. Dixon, J. B., and M. L. Jackson. DISSOLUTION OF INTERLAYERS FROM INTERGRADIENT SOIL CLAYS AFTER PREHEATING AT 400° C: Science, v. 129, no. 3363, fig., June 12, 1959, 11 refs.

Dehydroxylated interlayers have been removed from chlorite-vermiculite-montmorillonite intergrades by boiling the preheated sample in 0. 5N NaOH for 2. 5 min. Elements extracted can be conveniently analyzed spectrophotometrically. A convenient method of estimating the amount of elements present in interlayer positions and preparing the sample for analysis for expanding and nonexpanding mineral components is thus provided. --Auth.

1-1474. Carroll, Dorothy, and Harry C. Starkey. LEACHING OF CLAY MINERALS IN A LIMESTONE ENVIRONMENT: Geochim. et Cosmochim. Acta, v. 16, no. 1/3, p. 83-87, 2 tables, May 1959, 6 refs.

Water saturated with CO_2 at about 25°C. was percolated through mixed beds of limestone or marble fragments and montmorillonite, "illite," and kaolinite in polyethylene tubes for 6 and 45 complete runs. The leachates were analyzed for SiO_2, Al_2O_3 and Fe_2O_3, but only SiO_2 was found. The minerals lost SiO_2 in this order: montmorillonite > kaolinite > "illite." The differential removal of SiO_2 during the short period of these experiments suggests a mechanism for the ac-

cumulation of bauxite deposits associated with limestones. --Auth.

1-1475. Kelley, Fred R., George B. Cleveland, and R. J. Arkley. **FIELD TRIP TO THE IONE CLAY AREA, HELD IN CONJUNCTION WITH THE SIXTH NATIONAL CLAY CONFERENCE, AUGUST 21, 1957:** In: Swineford, Ada, ed. Clays and Clay Minerals: National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 1-17, map, sec., graphs, 6 tables, New York, Pergamon Press, 1959, 8 refs.

Contains a road log: Berkeley to Ione, via Vallejo, Fairfield, Birds Landing, Rio Vista, and Woodbridge; and a description of clays and soils in the Ione area.

1-1476. Bradley, W. F. **CURRENT PROGRESS IN SILICATE STRUCTURES:** In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 18-25, 6 figs., New York, Pergamon Press, 1959, 13 refs.

Attention is called to the value to be derived from application of diffraction analysis of modern grade to specific, familiar, approximately known crystallizations. Features consequent to ordering of coordination polyhedra of differing sizes in layer structures are discussed, and their bearing upon relations between lattice parameters and chemical compositions are outlined. --Auth.

1-1477. DeVore, George W. **THE SURFACE CHEMISTRY OF FELDSPARS AS AN INFLUENCE ON THEIR DECOMPOSITION PRODUCTS:** In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 26-41, 5 figs., 3 tables, New York, Pergamon Press, 1959, 23 refs.

The problems of hydrous decomposition of alkali feldspars and the formation of the micaceous minerals from the decomposition products are discussed in terms of the surface chemistry and the Al-Si ordering of the feldspars, and a crystal growth model for the micas. --Auth.

1-1478. Yoder, Hatten S., Jr. **EXPERIMENTAL STUDIES ON MICAS: A SYNTHESIS:** In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 42-60, 15 figs. incl. illus., graphs, diags., table, New York, Pergamon Press, 1959, 32 refs.

The principal end members of the micas believed to be common in sediments have been synthesized and some of their stability relations determined. The polymorphs of muscovite and paragonite, the principal dioctahedral end members, obtained were 1Md, 1M and $2M_1$, and those of phlogopite and annite, the principal trioctahedral end members, 1Md and 1M or 3T. The range of stability of each of the polymorphs could not be fixed accurately because of the slow rate of transformation; however, the transformations 1Md → 1M → $2M_1$, were effected for muscovite and paragonite and 1M → 1Md or 3T and $2M_1$ → 1M or 3T for phlogopite. The growth characteristics of these micas in the laboratory are believed to be analogous to the formation of micas in sediments.

Knowledge of the synthetic micas contributes greatly to an understanding of the natural materials called illite, hydromica, and high-silica sericite. The dioctahedral members of these materials and related minerals may be delineated accurately in the system muscovite-Al-celadonite-pyrophyllite and their Fe analogues. The trioctahedral members of some of the same materials may be outlined in the system phlogopite-eastonite-talc and their Fe analogues. The postulated substitution schemes in these systems are mainly $MgSi \rightleftharpoons Al^{VI}Al^{IV}$, $KAl \rightleftharpoons Si$, and $H_3O \rightleftharpoons K$. In materials intermediate between these systems, such as most biotites and vermiculites, the substitution of $3Mg \rightleftharpoons 2Al^{VI}$ is of major importance. The mixed-layer structures involving micas are elucidated. --Auth.

1-1479. Preisinger, Anton. **X-RAY STUDY OF THE STRUCTURE OF SEPIOLITE:** In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 61-67, 3 figs., 2 tables, New York, Pergamon Press, 1959, 5 refs.

Sepiolite is a valid mineral with the following chemical formula:

$$8MgO \cdot 12SiO_2 \cdot \underline{n}H_2O.$$

Its unit cell characteristics are:

$$\underline{a} = 13.4\text{Å}; \ \underline{b} = 26.8\text{Å}; \ \underline{c} = 5.28\text{Å}; \ \underline{Z} = 2; \ \underline{D}\ {}^{6}_{2\underline{h}}\text{-}\ P\ \frac{2_1}{\underline{n}}\ \frac{2}{\underline{c}}\ \frac{2}{\underline{n}}.$$

They were determined on the sepiolite from Ampandrandava (Madagascar). Its structure was determined by means of the "trial and error" method and the observed and calculated intensities rendered a good agreement.

The formula of the structure is:

$$\frac{1}{\infty}[H_2O]_{\underline{n}} \cdot \frac{1}{\infty}\{(Mg, Fe^{3+}, Fe^{2+}, Al)_8(H_2O)_4(O, OH)_4 [(Si, Al)_{10}O_{30}]\} \quad \cdot \underline{n} \leqslant 8.$$

The mineral contains zeolitic, crystal- and constitution-water. A good agreement was achieved between the chemical, thermal, and morphological qualities and the X-ray data. The mineral remains stable up to about 350°C. and begins to change into an "anhydride" above this temperature.

The formula of the structure of sepiolite- "anhydride" is:

$$\frac{1}{\infty}\{(Mg, Fe^{3+}, Fe^{2+}, Al)_8(O, OH)_4[(Si, Al)_{10}O_{30}]\}.$$

Its unit cell characteristics are:

$$\underline{a} = 10.9\text{Å}; \ \underline{b} = 23.3\text{Å}; \ \underline{c} = 5.28\text{Å}; \ \alpha \approx 90^{\circ}; \ \underline{Z} = 2; \ C_{2\underline{h}}^{5} - P\ \frac{2_1}{\underline{n}}\ 11.$$

The minerals xylotile, mountain wood and gunnbjarnite are isotypical with sepiolite. --Auth.

1-1480. Garrels, R. M., and Peter Howard. **REACTIONS OF FELDSPAR AND MICA WITH WATER AT LOW TEMPERATURE AND PRESSURE:** In: Swineford, Ada, ed. Clays and Clay Minerals.

National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 68-88, 9 figs., 3 tables, New York, Pergamon Press, 1959, 12 refs.

Muscovite and K-feldspar (adularia) were dry-ground to -200/in. particles, which were suspended in water. These suspensions were "titrated" with KCl, and the pH was recorded as a function of KCl concentration and temperature. The results indicate that muscovite and adularia react with water to produce a surface film in which H^+ has displaced K^+. The "titration" curves show some characteristics attributable to exchange reactions, others apparently related to equilibria among solids of fixed composition. Maximum release of K^+ from adularia by reaction with water is much greater than that from mica. The interpretation is made that the first result of reaction of mica and adularia with water is a surface layer that grades from an outer portion that is structurally disrupted to an inner portion that retains the original silicate structure but with H^+ substituted for K^+. Addition of K^+ as KCl to the suspending solution displaces H^+ from the disrupted zone, but all H^+ originally taken up by the solids was not returned to the solution by concentrations of KCl up to 1.0 M. Experiments were of a few hours duration; work by others has shown that the disrupted zone releases appreciable concentrations of silica and alumina to solution over longer time intervals.

These hydrolysis experiments indicate that at 25°C. an H-feldspar or H-mica structure is favored over a K-feldspar or K-mica structure except in solutions in which the ratio of a_{K^+}/a_{H^+} exceeds 10^{9-10} or 10^{7-8} respectively. These ratios decrease in the temperature range 25-65°C. by a factor of about $10^{0.7}$. These results, where considered in relation to the observed behavior of feldspar and mica under weathering conditions, indicate that the major energy change for the reactions,

$$2 \text{ mica} + 5H_2O = 3 \text{ kaolin} + 2K^+ + 2OH^-$$
$$3 \text{ K-feldspar} + 2H_2O = \text{K-mica} + 6 \text{ quartz} + 2OH^-$$

can be considered to result from H^+-K^+ exchange, and that the energy contribution from other changes is small. --Auth.

1-1481. Meyer, Charles, and Julian Hemley. HYDROTHERMAL ALTERATION IN SOME GRANODIORITES: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 89-100, 2 figs., table, New York, Pergamon Press, 1959, 16 refs.

The patterns of distribution of the mica and clay minerals resulting from alteration of feldspars are much less regular and well defined in the "porphyry copper" deposits than in the vein deposits such as those at Butte, Montana. There are, however, interpretative problems common to both. Chemically, the destruction of the K-feldspars may be interpreted in the light of laboratory investigations of the system potash-alumina-silica-water at various K^+/H^+ ratios. The experiments indicate that the K-mica (sericite) stability field lies between the K-feldspar and kaolinite fields. The K-mica field is approximately 1.5 pH unit wide, and its boundaries with K-feldspar and kaolinite are parallel below 500°C. The boundaries slope toward higher K^+/H^+ ratios at lower temperatures. Thus, considering the K-feldspar-sericite-kaolinite system of minerals, one might expect field patterns showing a central zone of kaolinite bordered by a zone of K-mica which in turn grades outward into unaltered K-feldspar. Such a pattern is demonstrated by Butte's inner dickite-kaolinite and sericite and possibly by the zoning at San Manuel described by Schwartz. Alteration of plagioclase introduces additional complications into the distribution patterns of clay and mica minerals, the chief of which is the outer argillic zone so characteristic of both vein and disseminated deposits. --Auth.

1-1482. Taylor, H. F. W. THE DEHYDRATION OF TOBERMORITE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 101-109, 3 figs., 3 tables, New York, Pergamon Press, 1959, 10 refs.

Tobermorite [$Ca_4 (Si_6O_{18}H_2)Ca \cdot 4H_2O$] is a hydrated calcium silicate mineral with a layer structure which in some respects resembles that of vermiculite. Its dehydration has been studied using single crystals from Ballycraigy, N. Ireland. The 3 most frequently encountered hydration states are characterized by basal spacings (d_{002}) of 14.0, 11.3, and 9.35 Å. Dehydration to the 9.35Å state is complete by 300°C. and is accompanied by a stacking change so that the pseudo-cell (a 5.58, b 3.66, c 18.70 Å) becomes A-face centered. The 9.35 Å structure persists up to 700°C., by which temperature all the water has been expelled, and there is some evidence that interlayer Si-O-Si bonds are formed to an increasing extent as the temperature rises.

At about 800°C., the 9.35 Å hydrate changes to β -$CaSiO_3$ twinned in 2 orientations. The b-axis of the 9.35 Å hydrate becomes b for both orientations of the product, and the (201) planes of the latter are formed parallel to the (101) and ($10\bar{1}$) planes of the original material. The mechanism of the change is discussed and is compared with some other transformations occurring under similar conditions. An orientation-determining step is suggested in which the principal effect is a migration of Si atoms or ions, the Ca-O skeleton remaining relatively undisturbed. --Auth.

1-1483. Barshad, Isaac. FACTORS AFFECTING CLAY FORMATION: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 110-32, 14 figs., 4 tables, New York, Pergamon Press, 1959, 15 refs.

Barshad's method of calculating clay formation from the chemical analyses of the whole soil, the clay fraction, the nonclay fraction, and the mechanical analysis was applied to a large number of soils to determine the effect of climate, topography, parent material, vegetation and time on amount of clay formation. The amount of clay formed from 100 g. of the nonclay fraction of the parent material was used as the yardstick for comparing clay formation in the different soils.

It was found that for a true evaluation of the effect of these factors on clay formation, it is necessary to determine clay formation in every horizon of a profile and that all soil profiles should be sectioned into horizons which are as nearly alike in thickness as possible. Maximum clay formation in a soil profile occurs in the horizon which is about 2-10 in. below the surface rather than at the immediate surface; as a rule, the amount of clay forming decreases below

this maximum horizon. An increase in moisture and temperature enhances clay formation. The temperature factor mainly affects clay formation in the Great Soil Groups in the following order: Podzols < Gray Brown Podzols < Brown Earths < Chernozems < Prairies < Red and Yellow Earths (Latosols) < Laterites. Poor drainage enhances clay formation. Grass-type vegetation is more effective in clay formation than tree-type. Clay formation is greater from the finer grained and the more basic rocks. The more easily rocks fragment, the more clay is formed. The increase in age of a soil is believed to be expressed in the same manner as an increase in the intensity of clay formation, namely, as an increase in clay formation with depth and as an increase in the thickness of a soil profile. It was concluded that clay formation is relatively slow: clay forms at a rate ranging from 0.00001 g. to 0.002 g. of clay per year per 100 g. parent material or from 0.6 to 120 lb. of clay per acre foot of parent material per year. --Auth.

1-1484. Jackson, M. L. FREQUENCY DISTRIBUTION OF CLAY MINERALS IN MAJOR GREAT SOIL GROUPS AS RELATED TO THE FACTORS OF SOIL FORMATION: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 133-43, New York, Pergamon Press, 1959, 46 refs.

The frequency distribution or relative abundance of minerals in soils varies with the 5 principal classes of factors that govern soil formation. The characteristics of the minerals of the parent material, the time factor, climatic factors, relief factors, and biotic factors each can be shown to have important independent effects on clay mineralogy of soils under proper circumstances. The soil parent material exerts a control over the frequency distribution of minerals in soils by introduction of the clay minerals into the soil directly, by controlling the course of chemical weathering in the soil through the relative susceptibility of its minerals to weathering, by furnishing abundant divalent metallic cations, by impediment of drainage, or by acceleration of leaching when highly permeable. The time factor is conspicuous as long times give an advanced degree of weathering even in temperate climates. Climate is important, since highly weathered materials inevitably occur as a result of intense leaching in warm tropical and equatorial climates. Relief is important in concentrating leaching water and metallic cations, in affecting oxidation or reduction. The biotic factor affects minerals conspicuously where an A_0 horizon develops and resulting cheluviation moves R_2O_3 out of the A_2 horizon.

Inherited minerals such as illite, quartz, feldspars, ferromagnesian minerals, carbonates and gypsum are most abundant in clays of little-weathered parent materials and soils of the zonal Desert, Brown, Chestnut and Tundra soils as well as intrazonal Mountain groups and azonal Regosols and Lithosols. Secondary layer silicate minerals such as vermiculite, secondary chlorite, montmorillonite, kaolinite and halloysite are most abundant in clays of moderately weathered parent materials and soils of the zonal Chernozem, Prairie, Gray-Brown Podzolic, Podzol, Red-Yellow Podzolic, and Low Humic Latosol groups as well as intrazonal Planosol, Rendzina, Dark Magnesium soil, and Wiesenboden groups. Secondary sesquioxide minerals such as hematite, goethite, allophane, gibbsite, and anatase, and residual resistant primary minerals such as ilmenite and magnetite predominante in the more highly weathered parent materials and soils of the zonal Ferruginous Humic Latosols, Hydrol Humic Latosols, Latosolic Brown, and Ando soils and Laterites, as well as the intrazonal Tropical Savannah and Ground Water Podzol ortstein soils. --Auth.

1-1485. Harrison, Jack L., and Haydn H. Murray. CLAY MINERAL STABILITY AND FORMATION DURING WEATHERING: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 144-53, 5 figs., table, New York, Pergamon Press, 1959, 3 refs.

Clay minerals undergo significant changes when exposed to weathering agents. Some of these changes were revealed by studying a sequence of samples collected from weathering profiles developed on shales. Illite and chlorite are modified by the development of expandable layers within the illite and chlorite structures. The suggested mechanism of alteration of chlorite is the oxidation and removal of octahedral Fe. Chemical analyses indicate that interlayer K is removed from illites. Removal of K may be accomplished by an exchange reaction between K ions and hydronium ions in the environment.

The origin of underclays is controversial. In an attempt to shed some light on this subject, 3 shale-underclay profiles were studied. The changes in clay minerals from shales to underclays are very similar to those in weathered shale profiles. This similarity lends support to the theory that some underclays are products of weathering. --Auth.

1-1486. Weaver, Charles E. THE CLAY PETROLOGY OF SEDIMENTS: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 154-87, 5 tables, New York, Pergamon Press, 1959, 101 refs.; also pub. as: Shell Oil Co., Tech. Services Div., Pub. no. 22.

Studies of the Recent indicate that, at the most, somewhat less than half the clay minerals are altered to any extent in a marine environment. Probably most of this alteration is in the form of cation adsorption or reconstitution of slightly weathered illites and chlorites to their original form. There appears to be little if any evidence that the detrital basic lattice is being altered to a measurable extent in Recent marine sediments. In the nearshore environments there is usually a coincidence of clay mineral suites and environments.

A major change in the clay mineral composition of sedimentary rock occurs within the Mississippian. Illite is the dominant clay mineral of the pre-Upper Mississippian sediments. Post-Lower Mississippian clay suites are more variable in composition; illite becomes less abundant and montmorillonite and kaolinite more abundant. This change is best related to a change in regional tectonics. The clay minerals seem to have no preferred lithologic associations, although owing to epigenetic alterations porous sandstones commonly have different clay mineral suites from those of adjacent shales and carbonate rocks.

In many instances clay mineral facies coincide with environmental facies. As the clay mineral criteria for distinguishing any given type environment are extremely variable, it is thought that segre-

gation of clay mineral suites by sorting is usually more effective than by diagenesis.

Expanded clay minerals appear to be partially contracted by the time they have been buried to 10,000-15,000 ft. It remains to be proved whether this is caused by chemical modification of the basic lattice with burial or if the detrital clay lattice has the inherent ability to contract, without chemical rearrangement, when buried to a sufficient depth. --Auth.

1-1487. Sand, L. B., and Gretta S. Baur. GENESIS OF KAOLINITE IN CRETACEOUS SHALES OF CENTRAL COLORADO: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 188-95, 6 tables, New York, Pergamon Press, 1959, 2 refs.

The refractory shales of the Purgatoire and Dakota formations in central Colorado were studied to determine the genesis of the kaolinite. The compositions of the shales were similar, with variation only in relative amounts and grain size of the component minerals. The shales consist primarily of kaolinite, subangular to subrounded quartz, and hydromuscovite, with minor amounts of feldspar, montmorillonite, mixed-layer clays, and occasional traces of gypsum and zeolites.

An inverse relation between the kaolinite and hydromuscovite contents suggests that hydromuscovite was an intermediate mineral in the formation of the kaolinite. Derivation of vermicular kaolinite from feldspar and mica was evident from examination of thin sections. The thinly banded interfingered lenses of montmorillonite suggest a detrital origin rather than alteration in situ of a volcanic ash to bentonite.

Genesis of the kaolinite probably is similar to that proposed recently by Kesler for the Cretaceous clays of Georgia and South Carolina whereby feldspathic sands deposited in a nearshore environment were subsequently weathered to produce residual kaolinite. Winnowing of some of these clays and redeposition in downstream lagoons formed the fine-grained, carbonaceous, "flint" clays, whereas the plastic clays were formed by introduction of detrital montmorillonite. --Auth.

1-1488. van Olphen, H. FORCES BETWEEN SUSPENDED BENTONITE PARTICLES. PART II - CALCIUM BENTONITE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 196-206, 7 figs., table, New York, Pergamon Press, 1959, ref.; also pub. as: Shell Devel. Co., Explor. & Production Research Div., Pub. no. 145.

In a previous paper data were presented for the rheological and sedimentation behavior of sodium bentonite suspensions in water. From these data particle interaction energies were derived. Analogous data have been collected for calcium bentonite suspensions. It was observed that more clay is required to obtain a gel or a certain sediment volume with calcium bentonite than with sodium bentonite. This result can be quantitatively interpreted on the basis of a larger average particle thickness in the calcium bentonite suspensions. It is furthermore concluded that the interparticle forces are of the same order in both calcium and sodium bentonite suspensions. --Auth.

1-1489. Granquist, W. T. FLOW PROPERTIES OF DILUTE MONTMORILLONITE DISPERSIONS: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 207-219, 6 figs., 3 tables, New York, Pergamon Press, 1959, 16 refs.

A viscometric study of dilute montmorillonite dispersions, using for the most part dilution-type capillary viscometers supplemented by a falling-head capillary viscometer, has involved a determination of the concentration dependence of viscosity of such dispersions in both distilled and electrolyte-containing water. The results of the study have been interpreted in terms of a theory of incremental viscosity, and of the Schulz-Blaschke equation. Use of this equation yields good extrapolations to zero concentration for the determination of limiting viscosity number and permits calculation of "interaction indices" which are considered, for reasons discussed in detail, to be a measure of particle-particle interaction. These indices are related to the cationic heat of hydration of the electrolyte used, and relationship is demonstrated between the yield stress of a 3% montmorillonite-electrolyte-water system and such interaction indices. The recent work of Packter is discussed, and the relation of the results of this investigation to the data of van Olphen is noted. --Auth.

1-1490. Kahn, Allan. STUDIES ON THE SIZE AND SHAPE OF CLAY PARTICLES IN AQUEOUS SUSPENSION: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 220-36, 13 figs. incl. illus., graphs, 8 tables, New York, Pergamon Press, 1959, 11 refs.; also pub. as: Shell Devel. Co., Explor. & Production Research Div., Pub. no. 147.

The size and shape of clay particles in aqueous suspension have been determined by means of 5 experimental techniques - electro-optical birefringence, ultracentrifugation, viscometry, optical transmission, and electron microscopy. Five clay minerals - montmorillonite, illite, hectorite, nontronite, and attapulgite - each subdivided into 5 size fractions, were studied. The average particle dimensions in each fraction are tabulated.

An evaluation of the experimental techniques is presented. It is concluded that for a preliminary survey of the particle size and shape of clay minerals the technique of electron microscopy is best. However, once a model for the particles is obtained, a combination of the techniques of electro-optical birefringence and viscometry becomes more useful in characterizing the size and shape of the particles in suspension. --Auth.

1-1491. Bates, Thomas F., and Joseph J. Comer. FURTHER OBSERVATIONS ON THE MORPHOLOGY OF CHRYSOTILE AND HALLOYSITE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 237-48, 9 illus., table, New York, Pergamon Press, 1959, 35 refs.; also pub. as: Pennsylvania State Univ., College of Mineral Industries, Contr. no. 57-57.

Electron microscope studies of chrysotile show that tubes are present in bulk specimens and that these tubes commonly have fuzzy, amorphous-looking

material on both the inside and outside. Similar material is associated with synthetic chrysotile and has been noted previously in halloysite specimens. The existence of such material between and within the tubes, together with apparent irregularities in size, shape, and packing of tubes, explains the apparent discrepancy between the measured density of bulk samples and the calculated density of a hypothetical sample consisting of close-packed, regular, hollow capillaries.

Replicas of fractured surfaces of halloysite ($2H_2O$) from various localities reveal that the particles occur as curved to flat laths commonly possessing "hexagonal" terminations and surface features indicative of a higher degree of crystallinity than tubes of halloysite ($4H_2O$).

It is suggested that a complete morphological series from plates through laths to tubes exists both in platy to fibrous serpentine and in kaolinite to halloysite ($4H_2O$). In each series a number of structural varieties are to be expected between the morphologically distinct "end members."--Auth.

1-1492. Johansen, Robert T., and H. N. Dunning. WATER-VAPOR ADSORPTION ON CLAYS: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 249-58, 3 figs., 2 tables, New York, Pergamon Press, 1959, 16 refs.

The distinctive response of clay minerals to water indicated that it should be possible to determine the water sensitivities of sedimentary rock samples directly by water-vapor adsorption measurements. Therefore, the adsorption of water vapor by standard clay samples and by core samples from oil-producing formations has been investigated.

Water-vapor adsorption isotherms of the montmorillonite and kaolinite samples are characteristic of the clay type and serve as an aid in their identification. The illite isotherm was intermediate between those of the other 2 types.

Water-vapor adsorption by core samples from oil-producing formations varied with the contents of swelling clays and with water-sensitivities as indicated by previous X-ray analyses and permeability studies. Core samples containing montmorillonite clay adsorbed water vapor strongly and exhibited typical adsorption-desorption hysteresis. Correlations of N and water-vapor adsorption studies with clay analyses and permeability measurements show that the water-vapor adsorption method is a promising means for the direct measurement of the water sensitivities of sedimentary formations.--Auth.

1-1493. Martin, R. Torrence. WATER-VAPOR SORPTION ON KAOLINITE: HYSTERESIS: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 259-78, 7 figs., 5 tables, New York, Pergamon Press, 1959, 8 refs.

Detailed water-vapor sorption measurements were made on Li, Na, K, Cs and Mg kaolinite at 25°C. When desorption is started from P/P_o near saturation, all ionic modifications show reversible hysteresis. The size and P/P_o range of the hysteresis loop varies with the nature of the exchangeable ion and sample history.

No hysteresis occurs on Li and K kaolinite when desorption is started at $P/P_o < 0.8$ which along with other data indicates that Li and K exchangeable ions are not truly hydrated below $P/P_o = 0.8$. The hysteresis for all ionic modifications is traced to hydration of the exchangeable ions. The apparent anomalous position of Li and K ionic hydration is attributed to control of hydration of exchangeable ions by the difference between the hydration energy of the ion minus the specific adsorption energy of the ion for the clay. This difference must be positive before true ionic hydration occurs.

A molecular model for sorption is postulated in which sorption is assumed to take place at specific sorption sites upon the clay surface. The energy of sorption at different sites is believed to be different and also to be a function of the hydration state of the exchangeable ion. By the use of the proposed model and the detailed sorption data, hydration of the different exchangeable ions as a function of the relative vapor pressure can be obtained. The sorption model also predicts phase changes in the sorbed film at certain relative pressures. These calculated phase changes agree very well with phase changes indicated from Jura-Harkins' plots of the experimental data.--Auth.

1-1494. Takahashi, Hiroshi. EFFECT OF DRY GRINDING ON KAOLIN MINERALS: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 279-91, 11 figs. incl. illus., graphs, 4 tables, New York, Pergamon Press, 1959, 15 refs.

The effect of dry grinding of kaolin minerals by a mechanical mortar was examined by X-ray, thermal, and electron microscopic methods. Base exchange capacity and apparent density were also measured. In the early stage of grinding, kaolin crystals cleave and fracture and then split into fine crystals which are considered unit crystallites. Such crystallites gradually change to a disordered kaolin and partially decompose into a noncrystalline substance as grinding progresses. The crystalline and the noncrystalline substances promptly reaggregate and these reaggregated particles have a radial shape. After further grinding, the structure of the reaggregated particle seems to be zeolitic. Finally, the kaolin mineral thoroughly changes to a completely amorphous substance similar to a silica-alumina mixed gel. Consequently, the effect of dry grinding of kaolin is related to the degree of crystallinity of the original kaolin mineral.--Auth.

1-1495. Granquist, W. T., and G. Gardner Sumner. ACID DISSOLUTION OF A TEXAS BENTONITE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 292-308, 5 figs., 10 tables, New York, Pergamon Press, 1959, 11 refs.

Various physical properties of an acid-treated Texas bentonite were studied as a function of treatment time. The observed kinetics were pseudo first-order (large excess of acid) and on this basis and the X-ray results a model and mechanism are proposed that are consistent with observed surface area, exchange capacity, and surface acidity changes. A crude estimation of activation energy gave a value lower than that of Osthaus but of the right magnitude.--Auth.

1-1496. Powers, Maurice C. ADJUSTMENT OF CLAYS TO CHEMICAL CHANGE AND THE CONCEPT OF THE EQUIVALENCE LEVEL: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 309-326, 3 figs., 3 tables, New York, Pergamon Press, 1959, 22 refs.

Further X-ray and chemical work on suspended sediment samples and cored samples from the James River and its estuary support earlier proposals by the author. A chlorite-like clay is forming from weathered illite through a mixed-layer illite-vermiculite-chlorite stage, and some illite is seemingly regenerated to a better illite by K fixation.

Chemical analyses of interstitial water, hydrochloric acid-leachate, and fused samples offer explanations regarding the chemical changes occurring in clays as composition of the environment changes.

Mg is adsorbed by clays to a far greater degree than K in the marine and brackish environment.

The variance between clays found in Recent and ancient sediments is related to and explained by the concept of the equivalence level. It is suggested that K^+ is adsorbed preferentially to Mg^{2+} by clays when they have been buried to a depth that is greater than that of the Mg^{2+} - K^+ - equivalence level; above this level Mg^{2+} is preferentially adsorbed by the clays.

The trifold nature of clay minerals in terms of their origin and distribution is briefly discussed. --Auth.

1-1497. Burst, J. F., Jr. POSTDIAGENETIC CLAY MINERAL ENVIRONMENTAL RELATIONSHIPS IN THE GULF COAST EOCENE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 327-41, 10 figs., New York, Pergamon Press, 1959, 8 refs.; also pub. as: Shell Devel. Co., Explor. & Production Research Div., Pub. no. 155.

An extensive survey of clay mineral relationships in the subsurface Wilcox formation (Eocene) has shown progressive diagenetic conversions with depth. Montmorillonite, a common constituent of Wilcox outcrop material, becomes less evident below 3000 ft. and is not normally found in an unmixed state below the 9000-10,000 ft. overburden level. At depths between 3000 and 14,000 ft., montmorillonite lattices are commonly interpersed with illite components, the frequency of which increases with depth to a virtual elimination of montmorillonite swelling characteristics below 14,000 ft.

Chlorite is present at all stratigraphic levels including surface exposures. It appears to be a more dominant constituent at depth; however, observed increases in basal intensities in samples that had been more deeply buried may result from more perfect crystal development rather than quantitative differences.

The diagenetic conversion of montmorillonite to illite and possibly to chlorite has resulted in a distribution of the last 2 minerals that is related to estimated depositional environments as reconstructed from micropaleontological criteria in at least one well in southern Louisiana. It is inferred, therefore, that different chemical characteristics in the ancient Wilcox seas are responsible for the distribution coincidence even though the mineral groups defining the distribution were not necessarily indigenous to the ancient Wilcox sea.

Correlations between clay minerals and environment are not particularly noted in the investigation of analogous environmental situations in Recent sediments, and it is thus concluded that the environment indicators which appear as minerals in lithified sediments such as the Wilcox are present in freshly deposited sediments in the form of submineralic chemical constituents such as absorbed ions, molecular groups or subcrystalline lattice configurations which are not detected by the ordinary clay mineral identification procedures. The change to mineralic form is aided by the natural "bombing" resulting from normal increases in temperature and pressure due to burial. The process is apparently a continuum through the entire subsurface residence of the sediment, and the results are seemingly in accordance with phase equilibria. --Auth.

1-1498. Bundy, Wayne M., and Haydn H. Murray. ARGILLIZATION IN THE COCHITI MINING DISTRICT, NEW MEXICO: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 342-68, 10 figs. incl. illus., graphs, 5 tables, New York, Pergamon Press, 1959, 66 refs.

Volcanic and intrusive rocks (mainly andesite and monzonite) of Tertiary age are associated with Au- and Ag-bearing quartz veins. Hydrothermal alteration took place in 2 stages. The first and less intense alteration stage is associated with economic mineralization; metallization during the second and more intense stage is limited to pyrite.

Alteration zones from the vein outward include: (1) dickite, (2) illite-kaolinite, (3) vermiculite-halloysite, and (4) chlorite-montmorillonite. Mixed-layer associations of 2:1 clay minerals are abundant and represent transitions between discrete clay minerals. Apparent occurrence of allophane in the illite-kaolinite zone indicates that amorphous aluminum silicates are intermediate phases in transitions from 2:1 to 1:1 clay minerals.

Alteration of ferromagnesian minerals and plagioclase resulted largely in the formation of 2:1 clay mineral types. Orthoclase is altered chiefly to illite and kaolinite. Dickite and quartz are end products of the most intense alteration in the area.

Chemical analyses of the altered rocks in general show a decrease in basic ions toward the vein. Less significant changes are shown by acidic ions. Analyses of illites indicate that substitution of K by Na, Fe, Ca and Mg has taken place near the vein as shown by an overall decrease in K/Na, K/Fe, K/Ca and K/Mg ratios. Both Na and K seem to be instrumental in the formation of well-developed illite crystals.

Alteration stages operative in the Cochiti district were developed by the action of solutions probably ranging in pH from 4 to 10. Alteration zones were formed penecontemporaneously with gradual outward migration of the least intense zones. --Auth.

1-1499. Weintraub, Judy, and L. B. Sand. ALTERATION OF MICACEOUS MINERALS BY SULFIDE SOLUTIONS: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 369-77, 5 figs., 3 tables, New York, Pergamon Press, 1959, 3 refs.

A mineralogical study by the U. S. Bureau of Mines and the University of Utah of the shale beds on the 1600-ft. level of the Ophir Hill mine, Utah,

disclosed that the micaceous minerals in the shale were altered as a function of proximity to the sulfide ore zones. The principal mineral in the shale distant from ore is 2M sericite. Within 100 ft. along the bedding plane and 15 ft. normal to the bedding plane, the sericite was altered successively to a modified form of sericite, 2 polymorphs of chlorite, and finally phlogopite.

A general sequence of the mineral changes from barren to ore-bearing ground was: (1) sericite; (2) modified sericite; (3) modified sericite and 7 Å chlorite (4) modified sericite, 14 Å chlorite, and phlogopite; (5) 14 Å chlorite and phlogopite, and (6) phlogopite. This sequence of alteration of sericite in the shale was not noted in the mine areas barren of ore. --Auth.

1-1500. Ames, L. L., and L. B. Sand. HALLOYSITE FORMED IN A CALCAREOUS HOT SPRING ENVIRONMENT: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 378-85, 6 figs. incl. illus., maps, sec., New York, Pergamon Press, 1959, 10 refs.

An unusual halloysite deposit occurs on the W. side of the Lake Mountains in Utah County, Utah. A field and laboratory study was made of this Fox deposit to determine the paragenesis of the clay minerals, especially halloysite. Successive lenses of unaltered tuff, partially altered tuff, clay and travertine beds, indicate that the clays have resulted from alteration of siliceous volcanic tuffs in a Tertiary(?) calcareous hot spring environment. Clay minerals identified were montmorillonite, kaolinite, halloysite · $4H_2O$ (endellite) and halloysite · $2H_2O$. Montmorillonite, which developed in a zone of less intensive silica leaching farthest from the hot spring vents, is the predominent clay mineral. Irregularly distributed pockets of halloysite and kaolinite developed nearest the hot spring vents in a high-calcium environment. In the clay, or associated with it, are calcite as travertine, quartz as rounded carbonate-corroded grains, feldspar, tridymite, biotite and glass.

Experiments that approximate the chemical environment prevalent in the halloysite alteration zone were conducted on phase relations in part of the system lime-alumina-silica-water. Results suggest the formation of halloysite · $4H_2O$ in this kinetic system from intermediate calcium aluminate or calcium silicate hydrates with halloysite-type structures, or both. --Auth.

1-1501. Ehlmann, Arthur J., and L. B. Sand. OCCURRENCES OF SHALES PARTIALLY ALTERED TO PYROPHYLLITE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 386-91, 6 figs. incl. illus., map, sec., New York, Pergamon Press, 1959, 7 refs.

Examination of samples from shale outcrops on the periphery of the Utah Valley graben has revealed an unusual association of disseminated pyrophyllite with various clay minerals. Numerous samples were obtained from exposures in brick clay pits located in the Manning Canyon formation of Mississippian-Pennsylvanian age and from the Long Trail member of the Great Blue formation of Mississippian age. Associated clay minerals in these beds include illite, illite-montmorillonite mixed-layer clays, 7Å chlorite, 14Å chlorite, kaolinite and sericite. Associated nonclay minerals include quartz, calcite, and small amounts of dolomite. Associated secondary minerals are calcite, aragonite, jarosite, gibbsite and gypsum.

Three possible explanations of genesis have been considered in the present study: deposition of detrital pyrophyllite, surface weathering under special conditions, and hydrothermal or pneumatolytic activity. The third alternative explanation, hydrothermal or pneumatolytic activity, is believed to be the most acceptable. It is hypothesized that Mg, Fe, and interlayer cations have been removed from some of the original 2:1 layer clays in the shale by solutions localized along fault zones. --Auth.

1-1502. Sand, L. B., and L. L. Ames. STABILITY AND DECOMPOSITION PRODUCTS OF HECTORITE: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 392-98, graph, 2 tables, New York, Pergamon Press, 1959, 12 refs.

The Hector, California, bentonite has been found unusual in many respects, and its thermal stability under hydrothermal conditions is no exception. It is important that the stability of this bentonite be known, as it is an end member of the saponite series with all cation positions, excluding interlayer, in the structure filled. The information is applicable to studies of wall rock alteration in which saponites occur as alteration products associated with ore deposition.

This saponite has an upper thermal stability limit of 750°C., at 15,000 p. s. i. water pressure, at which temperature it decomposes. The only products observed were talc and vapor; above 780°C. the decomposition products observed were anthophyllite and vapor. Syntheses on the hectorite composition corroborate these decomposition temperatures and products.

Hydrothermal treatment at temperatures below about 450°C. produce no change in the X-ray diffraction pattern of hectorite: on drying, the lattice collapses to a basal spacing (10-12Å) approaching that of mica, and with ethylene glycol expands to 17Å. However, after hydrothermal treatment above this temperature and to decomposition at 750°C., the hectorite, after subsequent cooling, collapses on drying at 110°C. or less to 9. 4Å, but expands as before to 17Å with glycol saturation. Without the glycol treatment the resulting material could be mistaken for talc and considered the decomposition product of hectorite at the higher temperatures. This behavior also occurs using the synthetic hectorite but does not occur when using synthetic or natural saponites containing Al.

For comparison, the relative stabilities of some dioctahedral and trioctahedral layered minerals are given to show the consistently higher stabilities for the minerals whose octahedral positions are filled. --Auth.

1-1503. Lopez-Gonzalez, Juan de D., and Jesus Cano-Ruiz. SURFACE AREA CHANGES OF A VERMICULITE BY ACID AND THERMAL TREATMENT: In: Swineford, Ada, ed. Clays and Clay Minerals. National Conference on Clays and Clay Minerals, 6th, Berkeley, Calif., 1957. Proceedings, p. 399-405, 3 figs., 6 tables, New York, Pergamon Press, 1959, 14 refs.

A vermiculite from Beni-Uxera, North Africa, was refluxed with HCl solutions of various con-

centrations to determine the effect of such a treatment on its surface area. The treated vermiculite was analyzed for "free" SiO_2 and by X-ray diffraction, and the refluxing solutions were analyzed for the cations removed from the vermiculite. Surface areas were determined by means of adsorption isotherms of n-butane at 0^oC.

The surface area of the acid-treated vermiculite increases with increase in concentration of the acid. Heating of the acid-treated samples or the natural samples decreases the surface area.

The increase in surface area by acid treatment is due to destruction of the vermiculite and its conversion to a "free" form of SiO_2 which possesses a large surface area. X-ray analysis indicated that this "free" SiO_2 was not present in the interlayer positions of the crystal lattice of vermiculite. --Auth.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Areal and Regional Geology 1-1349, 1-1350, 1-1351; Geophysics 1-1448; Geochemistry 1-1451, 1-1458, 1-1461; Mineralogy 1-1481, 1-1498, 1-1499.

1-1504. Bailey, Edgar H. FROTH VEINS, FORMED BY IMMISCIBLE HYDROTHERMAL FLUIDS, IN MERCURY DEPOSITS, CALIFORNIA: Geol. Soc. America, Bull., v. 70, no. 5, p. 661-63, 4 illus. on pl., May 1959, 9 refs.

The froth veins have textures most easily explained as resulting from initial deposition of silica at interfaces separating a hydrous vein fluid and immiscible droplets of oil, followed by close packing of the silica shells and further deposition of silica between them. Locally cinnabar was deposited as a part of the original silica shell, indicating that the immiscible fluids also were ore fluids. --Auth. summ.

1-1505. Subramaniam, A. P. CHARNOCKITES OF THE TYPE AREA NEAR MADRAS - A RE-INTERPRETATION: Am. Jour. Sci., v. 257, no. 5, p. 321-53, 3 figs. incl. 2 maps, 3 pls., 2 tables, May 1959, 32 refs.

Mutual relationship of the rock units in the type charnockite area near Madras city is described and the terms "Charnockite" and "Charnockite series" redefined. The "Acid" division of the charnockite series of Holland, composed of alaskites, birkremites, enderbites and hypersthene quartz syenites, is considered to be an igneous suite which has undergone metamorphic reconstitution and recrystallization, with concomitant changes in mineralogy such as unmixing of perthites and formation of garnet. The rocks of the "Basic" division of Holland are essentially pyroxene granulites and variants which have no genetic relationship to the charnockites sensu stricto. Sporadic exposures of norite with pyroxenite layers and lenses are considered syntectonic lenses, unrelated to the charnockite suite. The rocks of the "Intermediate" division of Holland grade from homogeneous hypersthene diorites to charnockite-pyroxene granulite migmatites, and are hybrids resulting from partial assimilation and incorporation of pyroxene granulite by the charnockitic magma. Garnetiferous sillimanite gneisses (khondalites) are also developed in force in the area; Holland's leptynites are inferred to be a thoroughly reconstituted and recrystallized facies of khondalite. The above association of charnockites, hybrid rocks, pyroxene granulites and recrystallized khondalites is also found in the larger massifs of southern India such as those of Nilgiri, Shevroy, and Palni. Mineralogical, petrographic and chemical data are presented to substantiate the reinterpretation. --Auth.

10. SEDIMENTARY PETROLOGY

See also: Areal and Regional Geology 1-1354; Stratigraphy 1-1386, 1-1388, 1-1395; Paleontology 1-1443; Geochemistry 1-1466; Mineralogy 1-1483, 1-1486, 1-1487, 1-1488, 1-1490, 1-1496, 1-1497, 1-1501; Geohydrology 1-1533; Mineral Deposits 1-1545, 1-1547; Fuels 1-1567.

1-1506. McNeal, Robert P. LITHOLOGIC ANALYSIS OF SEDIMENTARY ROCKS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 854-79, 6 figs., table, Apr. 1959, 57 refs.

The role of the subsurface stratigrapher increases in importance as the number of unexplored structural traps decreases, but little detailed information regarding the descriptions and interpretations of sample cuttings has been made available in one publication.

Rocks may be described in sample cuttings as to rock type, color, grain or crystal size, cement or matrix, impurities, porosity, stain, luster, fossils, associated material, and subordinate features. Clastic rocks are divided into non-carbonate clastics, which include sandstone, siltstone, and clay, or shale, and carbonate clastics which include most types of limestone and dolomite. Non-clastic carbonate rocks (reefs and bioherms) can be composed to a great extent of clastic material, but they originate from and are retained by non-clastic organisms. Evaporites compose a third major rock type.

Sedimentary rocks may have interstitial and fracture porosity, and in addition, carbonate rocks may have solution porosity. Insoluble residues and paleontology are supplemental aids in establishing time surfaces and in indicating environments. Several simple tests for determining mineralogy and oil shows can be made by a stratigrapher. He can also identify in sample cuttings several criteria for the recognition of unconformities. --Auth.

1-1507. Nagy, Bartholomew, and John P. Wourms, Jr. EXPERIMENTAL STUDY OF CHROMATOGRAPHIC-TYPE ACCUMULATION OF ORGANIC COMPOUNDS IN SEDIMENTS: AN INTRODUCTORY STATEMENT: Geol. Soc. America, Bull., v. 70, no. 5, p. 655-59, fig., table, May 1959, 10 refs.

Organic compounds may be concentrated in layers of sedimentary rocks by chromatographic-type processes. The same mechanisms may lead to the separation of mixtures of organic compounds and to the concentration of the fractions in rock strata. The chromatographic processes are the result of fluid flow through beds containing fine-grained mineral particles.

Ion-exchange chromatographic experiments using 2 triphenylmethane dyes (crystal violet and rosaniline) and adsorption chromatographic experiments run to illustrate this are described, and the results are given. --M. Russell.

1-1508. Pettijohn, F. J., and Harry Bastron. CHEMICAL COMPOSITION OF ARGILLITES OF THE COBALT SERIES (PRECAMBRIAN) AND THE PROBLEM OF SODA-RICH SEDIMENTS: Geol. Soc. America, Bull., v. 70, no. 5, p. 593-99, 3 figs. incl. map, 3 tables, May 1959, 18 refs.

Two new chemical analyses show that the varved argillites of the Precambrian Cobalt series of Ontario, Canada, contain more Na_2O than K_2O and have a Na_2O/K_2O ratio higher than most pelitic rocks but similar to that found in many graywackes. Published chemical data substantiate these observations. The Cobalt materials are also low in CaO but otherwise have a composition compatible with their presumed glacial origin.

Albitization of the detrital plagioclase feldspar seems to best account for the low lime and high soda content of these rocks. X-ray data confirm the presence of albite.

Spectrographic analyses of the argillites are also given. --Auth.

1-1509. Jacobsen, Lynn. PETROLOGY OF PENNSYLVANIAN SANDSTONES AND CONGLOMERATES OF THE ARDMORE BASIN: Oklahoma Geol. Survey, Bull. 79, 144 p., 44 figs. incl. illus., maps, secs., diags., graphs, 17 tables, May 1959, 83 refs.

The Pennsylvanian system in the Ardmore basin comprises as much as 18,000 ft. of sediment, of which the greater part is shale, about 20% is sandstone, and small amounts are conglomerate and limestone. The major stratigraphic units recognized in the basin are, from the oldest to the youngest, the Goddard shale, Springer formation, Dornick Hills, Deese, Hoxbar, and Pontotoc groups. These sediments are preserved in a narrow syncline between uplifts of the Arbuckle and Wichita mountains in S.-central Oklahoma, and the basin margins are in considerable part high-angle faults of large displacement.

Non-arkosic conglomerates occur at 20 or more stratigraphic levels in the Dornick Hills, Deese, and Hoxbar groups. They are present as wedge-shaped units of rock which thin toward the center of the basin and thicken toward the margins. Chert is by far the most abundant pebble type in the conglomerates, though limestone is locally abundant where the conglomerates are exposed near the borders of the basin. The modal size of the pebbles is about 1/2 in., but fragments reach a maximum of 12 in. in diameter. In most occurrences the conglomerates have a quartzose sand matrix which gives them a strongly bimodal size distribution.

The conglomerates are interpreted as fan-shaped basin margin accumulations which were localized by fault-controlled topography. They are significant because they show that deformation of the bordering uplifts was intermittent throughout the period of Pennsylvanian sedimentation. The distribution of the conglomerates suggests that faulting and sharp uplift began on the southern margin of the basin during Dornick Hills deposition but on the N. and NE. margins not until after the beginning of Deese sedimentation.

Four relatively well-defined types of sandstone are recognized. One is essentially restricted to the Springer formation, and is characterized by having either quartz alone or quartz and "clay" as the only major constituents, and a tourmaline, zircon, and rutile assemblage of non-opaque accessory minerals.

A second type makes up the sandstones of the Dornick Hills and Deese groups, and much of those of the Hoxbar group. These sandstones are characterized by abundant rock fragments, mostly shale, and a heavy mineral assemblage of garnet, staurolite, chloritoid, chlorite, and clinozoisite, in addition to the ultra-stable minerals

These two types are similar in texture. Both are very fine to fine grained, and very well sorted. The grains are relatively angular, and have a mean roundness of about 0.40. Bonding is generally weak, but there are examples of bonding by authigenesis of clay minerals, and cementation with calcite, siderite, or secondary quartz.

The third, and least abundant, of the 3 sandstone types was found only in outcrops of the Hoxbar group. Its distinguishing features are the presence of well-rounded quartz and stable heavy minerals, and abundant detrital limestone fragments. These constituents make up an easily recognized polar type, but most of the Hoxbar sandstones are mixtures, in a considerable range of proportions, of this assemblage and that which characterizes the Deese and Dornick Hills sandstones.

A fourth type is the arkoses of the Pontotoc group. These are tectonic arkoses, and show little modification by chemical weathering and transport. The granitic debris is commonly mixed with sedimentary rock fragments, including limestone, from the earlier Pennsylvanian and pre-Pennsylvanian formations of the Arbuckle Mountains. The arkoses are the distinctive rocks of the Pontotoc group, but Pontotoc sandstones similar in lithology to those of the Deese and Hoxbar groups are probably more common.

The immediate source of the Springer sandstones could not be satisfactorily determined by comparative petrography. The ultimate source was probably a largely metamorphic terrane, and the sandstones have become texturally and mineralogically relatively mature by the largely physical breakdown of their less stable constituents in several cycles of sedimentation.

The post-Springer sandstones are chiefly a mixture of detritus from nearby uplifts, and in a general way record the progressive unroofing of these uplifts. The Deese and Dornick Hills sandstones are largely the product of the erosion of the Springer sandstones; the Hoxbar marks the exposure of the Ordovician orthoquartzites of the Arbuckle Mountains; and the Pontotoc group, the exposure of granite.

Post-Springer sedimentation was ultra-rapid, and as a result the detritus received minimum modification, and for the most part the sediments closely reflect their provenance. Mixing of detritus from more than one uplift or from several exposed lithologies is general. This is most conspicuous in the Hoxbar and Pontotoc sandstones, but all of the sediments may be regarded as a continuous series of increasing complexity with time as a result of exposure of additional areas and lithologies to erosion.

A special instance of mixing is the presence of a group of heavy minerals of metamorphic origin in most of the post-Springer sandstones. These can be shown to have had a source separate from the bulk of the now stable minerals, and are inter-

preted to indicate a relatively early Pennsylvanian exposure of basement rocks in the Red River uplift.

The local source, the thick sequence of sediments, the overall similarity of the sequence, and the common occurrence of basin-margin conglomerates suggest that deformation was essentially continuous during post-Springer sedimentation, and was characterized by abrupt local uplifts.

Although the conspicuous deformation occurred after the deposition of Springer sediments, some structural differentiation of the uplifts had occurred during Springer sedimentation. This is shown by the widespread slumped bedding on the flanks of the large oil field anticlines, and the occurrence of a distinctive facies on and near the crest of these uplifts. The Springer rocks in general show evidence of being deposited in a somewhat stagnant quiet water environment, but on these structural highs the indicated environment is one of strongly agitated water which was oxidizing and alkaline,

The early growth of these uplifts was a critical factor in the petroleum accumulation which occurred in the Springer sandstones in that it caused the sedimentation of a favorable reservoir facies in proximity to a favorable source facies. --Auth.

1-1510. Lee, K. Y. PETROGRAPHIC STUDY OF CARY OUTWASH IN POTTER, WALWORTH, AND BROOKINGS COUNTIES, SOUTH DAKOTA: South Dakota Acad. Sci., Proc., v. 37, p. 149-54, 2 figs., 1959.

A detailed textural study of the Cary outwash in Potter, Walworth and Brookings counties shows that the outwash deposits of sand and gravel were formed in a sequence of 3 glacial conditions. First, normal glacial meltwaters deposited the finer sand and gravel; then flood conditions caused coarser material; then normal glacial conditions caused a return to finer sand and gravel deposition. The average weight percentage of each grain size limit of the outwash sediments is about 8% cobble, 48% pebble, 10% granule, 33% sand, and 1% silt and clay. The constituents of the coarse detritus, ranging from cobble to granule in size, average 47% limestone and dolomite, 32% igneous and metamorphic rocks, and 21% shale, ironstone, and sandstone. The sand and silt fractions are composed mainly of rounded to subrounded quartz with accessory minerals. On the basis of the physical properties, the sand and gravel, which occur throughout the outwash, are good water-bearing sediments, and fine materials for road and building construction. --Auth.

1-1511. Ireland, H. Andrew. INTRODUCTION TO SILICA IN SEDIMENTS: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 1-3, March 1959.

Silica occurs as amorphous to crystalline form in many types of igneous, metamorphic, and sedimentary rocks, but in sediments and sedimentary rocks much of the silica is detrital material. The chief forms of silica are hydrous opal, cryptocrystalline chalcedony, and crystalline quartz.

The primary aim of this symposium on silica in sediments is chiefly toward the geochemical and organic aspects rather than the study of detrital particles of silica. However, clastic deposits of siliceous organisms, volcanic ash, and other clastics serving as sources of silica are of interest.

Sedimentary silica enters into the development of authigenic quartz and silicates, into clay minerals, and into other secondary compounds as a result of geochemical action. The precipitation of chert, silicification of fossils, formation of skeletal parts and covering of organisms, cementation of particles, and the relation of silica to diagenesis are matters which warrant research and discussion.

Knowledge of the various aspects of silica in sediments is important economically in regard to mineral deposits, petroleum geology, and ground water. Regeneration of quartz particles, cementation by silica, and differential solution have a great effect on porosity and permeability of aquifers and petroleum reservoirs, thereby reducing or increasing petroleum or water accumulation. --Auth.

1-1512. Krauskopf, Konrad B. THE GEOCHEMISTRY OF SILICA IN SEDIMENTARY ENVIRONMENTS: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 4-19, 6 figs., March 1959, 41 refs.

Amorphous silica dissolves in either fresh or marine water to the extent of 100-140 p.p.m. at ordinary temperatures. This is true solution, not colloidal dispersion, most or all of the silica being in the form of monosilicic acid, H_4SiO_4. Crystalline forms of silica have lower solubilities, quartz least of all. The solubility increases as temperature rises, but is little affected by changes of pH in the range 0-9.

Silica ordinarily does not precipitate at once from supersaturated solutions, but forms a colloid. In concentrated solutions the colloid may eventually set to a gel or precipitate as flocculent masses, but in fairly dilute solutions the dispersed sol is very stable. At equilibrium the sol contains dissolved silica in amounts given by the figures above, in addition to the colloidal particles. The reactions of forming and disaggregating the sol particles are slow, so that supersaturated solutions of molecularly dispersed silica and very dilute solutions of colloidal silica can persist for days or weeks.

Colloidal silica may be precipitated by evaporation, by cooling, or by addition of electrolytes, but if the solution is at equilibrium the dissolved part of the silica does not precipitate. Precipitation of dissolved silica may be brought about by organisms, by adsorption, by reaction with cations to form silicates, and probably by slow approach to equilibrium with a crystalline form of silica.

In natural waters silica is mostly in true solution. Its concentration is less than the amount at equilibrium with amorphous silica, both because it is derived largely from materials less soluble than amorphous silica and because it is removed from solution by the processes described above. Most precipitated silica is disseminated widely through sediments. To form chert requires an unusually abundant supply, diagenetic redistribution of freshly precipitated silica, or later replacement. --Auth.

1-1513. Bien, George S., David E. Contois, and William H. Thomas. THE REMOVAL OF SOLUBLE SILICA FROM FRESH WATER ENTERING THE SEA: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 20-35, 11 figs. incl. chart, graphs, 10 tables, March 1959, 21 refs.; reprinted from: Geochim. et Cosmochim. Acta, v. 14, no. 1, p. 35-54, 1958.

Determinations of soluble silica and chlorosity of water samples collected in and around the E. Mississippi Delta showed that most of the soluble silica was removed from the river water by some process other than dilution with sea water. While biological uptake by diatoms can account for part of this removal, it is more likely that a major portion is removed by inorganic precipitation.

Laboratory experiments with river water and sea water showed that both suspended matter from the river water and electrolytes in the sea water are necessary for maximum inorganic precipitation. It is concluded that this process is an adsorption of soluble silica on suspended matter as it comes in contact with electrolytes, rather than a simple formation of salts with electrolytes. The inorganic removal can increase the weight of sediment in the water which may be expected to reach the bottom by a maximum of 4.5%. --Auth.

1-1514. Dapples, Edward C. THE BEHAVIOR OF SILICA IN DIAGENESIS: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 36-54, 9 figs., March 1959, 17 refs.

Chemical reactions between detrital minerals, the incorporated biota and their tests, and interstitial fluids are considered to tend toward equilibria under 3 different stages of diagenesis of sediments. Such stages are: initial or depositional, intermediate or early burial, and late burial or pre-metamorphic. Collectively the effect upon quartzose sandstones is: (1) During deposition, there is distinct pitting and rounding of quartz grains by solution, and instability of detrital chert, i.e., minor but persistent solution of silica. (2) Early burial is characterized by precipitation of quartz as overgrowths, i.e., minor but characteristic precipitation of quartz. (3) Late burial is characterized by addition of carbonate cement and as a replacement of quartz grains; or, where carbonate is absent, interpenetration of quartz grains increasing in degree with depth of burial or application of pressure as indicated by folding. Among subgraywacke sandstones chert tends to be metastable during the early burial stage and reacts with clay to form authigenic clay minerals and micas. Deep burial is characterized by introduction of carbonates corroding quartz and replacing the clay matrix, and authigenesis of mica from interstitial clay.

Occurrence of silica in Silurian carbonates with coral reef development shows interrelationships between carbonate minerals and chert which indicate chert is introduced during lithification of the reef flank sediments and precedes dolomitization.

Analyses of saline formation water from Paleozoic carbonate strata buried to depths of several thousands of feet within the Illinois Basin provide data which suggest that solubility of silica is independent of pH below values of 8, and that temperature may be the important control of silica solubility. --Auth.

1-1515. Siever, Raymond. PETROLOGY AND GEOCHEMISTRY OF SILICA CEMENTATION IN SOME PENNSYLVANIAN SANDSTONES: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 55-79, 6 figs. incl. map, 3 pls., table, March 1959, 33 refs.

Cementation in some 400 thin sections of Pennsylvanian quartzose sandstones of the Eastern Interior, Midcontinent, Michigan, and Appalachian basins was studied petrologically. Of these thin sections, 120 that showed significant amounts of mineral cement were studied in detail. Parameters measured included (1) amount of secondary silica, (2) the number of enlarged detrital grains that showed detrital outlines, (3) interpenetration of detrital grains, and (4) geometry of grain contacts. Amounts of clay matrix and other cements (carbonate, barite) had been determined in an earlier study.

The well known inverse relationship between mineral cement and clay matrix holds for these rocks, and thus mainly rocks with low clay content were in the group of slides studied in detail. The distribution of silica cement in these rocks is not clearly related to depth of burial, structural position, or stratigraphic horizon. Furthermore, silica cementation is not necessarily related to solution interpenetration of detrital grains. Thus the silica cement, precipitated from solution, may be tied to the chemistry of the original sedimentation environment or to the composition of ground-water solutions passing through the rocks. An evaluation of the chemistry of silica in solution and the solubility of quartz and amorphous silica as related to pH, temperature, and ionic strength of solutions, based on experimental work by Kennedy, Iler, Krauskopf, and others, leads to conclusions on the possible chemical environments that might produce silica precipitates. The petrology and knowledge of the general geology of the rocks then enables one to rate the relative probabilities of the several chemical environments that may account for the silica cements actually observed. Although relative time of precipitation can be determined from a petrologic study of the relations between various cements, the placement of the precipitate as "early," "middle," or "late" in the diagenetic history of the rock is best done by a combination of petrology and chemistry. --Auth.

1-1516. Riedel, William R. SILICEOUS ORGANIC REMAINS IN PELAGIC SEDIMENTS: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 80-91, 3 charts, table, March 1959, 25 refs.

Siliceous skeletal remains, principally of diatoms and radiolarians with smaller amounts of sponge spicules and silicoflagellates, constitute up to approximately 40% of some Recent pelagic sediments. The main factors controlling the contribution made by siliceous organisms to marine sediments are apparently (1) the rate of production of siliceous organisms in the overlying waters, (2) the degree of dilution of siliceous remains by terrigenous, volcanic and calcareous organic contributions to the sediment, and (3) the extent of solution of the siliceous skeletons, most of which apparently occurs shortly after deposition. Depth of water is apparently not an important direct factor, except insofar as it affects the amount of calcareous contributions to the sediments. The evidence at present available indicates that the production of siliceous organisms is high in the regions of the equatorial current systems and around the edges of the central water masses of the oceans, especially in areas of upwelling, and is much lower in those parts of the oceans in which the near-surface waters are more stably stratified. --Auth.

1-1517. Thomson, Alan. PRESSURE SOLUTION AND POROSITY: (In: Ireland, H. Andrew, ed. Silica

in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 92-110, 10 figs., 8 illus. on 4 pls., 2 tables, March 1959, 27 refs.

The lower Silurian Green Pond conglomerate of northern New Jersey contains numerous sandy zones of highly pressolved quartz grains. These zones are characterized by sutured upper and lower grain contacts, clay coatings around grains, high ratios of horizontal/vertical grain dimensions, and lack of secondary quartz. These features in adjacent unpressolved zones are characteristically the opposite. The presence of clay seems to be necessary for the development of highly pressolved zones. Several thermal analyses of this clay indicate that it is a highly degraded illite. Similar analyses of clay from nearby shales also indicate the presence of illite, but in a lesser state of degradation. It may be inferred that a positive correlation exists between degree of pressure solution and loss of K from the illite structure.

Solutions migrating through the sediment commonly are charged with CO_2 and various cations capable of replacing K. Loss of K from the illite structure results in the formation of K_2CO_3, a strong alkali. It is suggested that a pH differential of decreasing alkalinity radiates away from the zone of clay. As pressure and solubility increase due to weight of overburden, a threshold is reached beyond which quartz is dissolved at grain contacts in regions of highest pH. Silica, probably in the form of potassium silicate, migrates to regions which have a lower pH, and hence are below the threshold. There it is deposited as secondary overgrowths on unmodified quartz grains.

Pressolving the grains results in loss of porosity in high pH zones, but in places of low pH where pressure solution is unfavorable, porosity may be completely eliminated by cement derived from pressolved zones. Such complete cementation may limit remaining porosity to zones in which the degradation of illite prevents cementation, and in which, because of insufficient pressure or other reasons, pressure solution has not been important. --Auth.

1-1518. Swineford, Ada, and Paul C. Franks. OPAL IN THE OGALLALA FORMATION IN KANSAS: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 111-20, 12 figs. incl. illus., sec., table, March 1959, 14 refs.

Two distinct mineralogic types of opal are found in the various members of the Neogene Ogallala formation of western Kansas, where the opal occurs in abundant diatom tests, has replaced wood, has partly replaced siliceous roots and seeds, cements feldspathic sandstone, occurs in bentonite beds, and is present as discontinuous massive beds below a surface of late Pliocene and early Pleistocene weathering.

Four modes of origin are recognized: (1) biogenetic precipitation of opal as diatom tests; (2) addition of opal to silica-containing plants; (3) desilication of volcanic glass and precipitation of the silica in underlying rocks as opaline cement and replacement of wood; and (4) desilication in conjunction with calcium carbonate calichification below a late Pliocene-early Pleistocene weathering surface and precipitation of the silica as discontinuous opaline beds in the upper part of the Ogallala formation. --Auth.

1-1519. Pittman, J. S., Jr. SILICA IN EDWARDS LIMESTONE, TRAVIS COUNTY, TEXAS: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 121-34, 12 illus. on 6 pls., map, March 1959, 13 refs.

Silica occurs in the Edwards limestone [Lower Cretaceous] as microcrystalline quartz, chalcedonic quartz, megaquartz, detrital quartz grains, and opal. Microcrystalline quartz with minor chalcedonic quartz makes up chert nodules occurring in zones parallel to bedding planes. Many, but not most, nodules contain abundant sponge spicules, but examination of 200 insoluble residues failed to reveal spicules in the associated carbonate rocks. It is postulated that sponges and other organisms concentrated silica from sea water and that after death this silica was dissolved in places and precipitated in others as a function of pH. Persistence of bedding through nodules, presence of dolomite rhombs and rhomb ghosts, and perfection of preservation of fossils and carbonate fragments within the nodules are taken as proof of replacement. Cracks in some nodules are filled by the enclosing lime mud. This, together with the relationship with dolomite, shows replacement as a gel. Chert is too hard to break while enclosed in a plastic medium. Megaquartz occurs as irregular masses pervading and replacing shell material. Weathered surfaces often have a thin opal crust, and, in places, the outcrops are replaced by saccharoidal quartz to a depth of several inches. The surficial silicification is a result of weathering, and the source of silica is probably chert within the formation and above the water table. --Auth.

1-1520. Goldstein, August, Jr. CHERTS AND NOVACULITES OF OUACHITA FACIES: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 135-49, 15 figs. incl. 10 illus., 3 maps, 2 secs., March 1959, 9 refs.

A thick sequence of Paleozoic sedimentary and very low-grade metamorphic rocks of geosynclinal facies crops out in the Ouachita Mountains of eastern Oklahoma and western Arkansas. Similar rocks crop out also in the Marathon and Solitario uplifts of Trans-Pecos Texas. Data obtained from numerous well borings indicate that these outcrops are merely exposed minor segments of a long sinuous geosynclinal structural belt that stretches from eastern Arkansas into Mexico and is now buried beneath younger sediments. The term "Ouachita facies" is applied to both the rocks of the outcrop areas and the buried rocks of the structural belt.

In periods of active downwarping of the geosyncline, when large amounts of clastic detritus were available, the typical deposits in the Ouachita geosyncline were poorly sorted subgraywacke sandstone and impure clay shale. During periods of relative quiescence, when little clastic material was being supplied to the geosyncline, the sedimentary deposits were largely argillaceous limestone, siliceous shale, siliceous limestone, bedded chert, and novaculite.

In the Marathon uplift the major siliceous units are the Fort Peña chert (Ordovician), Maravillas chert (Ordovician), and Caballos novaculite (Devonian-Mississippian). In the Ouachita Mountains the major siliceous units are the Bigfork chert (Ordovician) and the Arkansas novaculite (Devonian-Mississippian).

It has been suggested by some authors that the high silica content of some of the cherts and novaculites is

an epigenetic feature resulting from a combination of surface exposure and from alteration of originally noncherty sediments during the orogeny in which the Ouachita geosyncline was compressed, deformed, and uplifted. However, the cherts and novaculites maintain similar lithologic and faunal characteristics in wells throughout the entire Ouachita structural belt, although most of these rocks never have been exposed at the surface.

The majority of the silica in the cherts and novaculites of Ouachita facies probably was supplied by extrusive volcanism and submarine weathering of volcanic ash. There has been some epigenetic redistribution of silica in the cherts and novaculites which crop out in the Ouachita Mountains and Marathon uplift, but this redistribution is considered to be relatively unimportant. --Auth.

1-1521. Bissell, Harold J. SILICA IN SEDIMENTS OF THE UPPER PALEOZOIC OF THE CORDILLERAN AREA: (In: Ireland, H. Andrew, ed. Silica in Sediments; a symposium...) Soc. Econ. Paleontologists & Mineralogists, Spec. Pub. no. 7, p. 150-85, 24 illus. on 12 pls., 7 maps (1 fold.), March 1959, 81 refs.

Sedimentation during the upper Paleozoic in the Cordilleran geosyncline involved the introduction and incorporation of tremendous quantities of siliceous materials within the limestone, orthoquartzite, and shale sequence. The repository had the characteris- of a miogeosyncline, yet chert is abundantly represented among the siliceous sediments. This material was deposited copiously in strata of Mississippian, Pennsylvanian, and Permian ages in thin beds, concretions, irregularly-shaped masses (blebs, "gobs," and nodules), and as replacement of fossils and other structures. Thus, the chert and other forms of silica occur as epigenetic, syn-diagenetic, and syngenetic deposits and replacements.

Silica in the sediments at some localities is penecontemporaneous with carbonate, arenite, and lutite sedimentation. In other places all of the siliceous material was introduced during post-depositional stages. And at still other places penecontemporaneous and post-depositional silica occur within a stratigraphic succession in an interbedded sequence. Petrologic and petrographic studies reveal sharp contacts with subjacent and superjacent strata locally, and elsewhere blended contacts are characteristic. These relations are particularly well shown in the various carbonates. Within the stratigraphic section of interbedded orthoquartzite, calcarenaceous orthoquartzite, and arenaceous limestone there occur numerous interesting examples of the host of silica types. Many of the arenites show evidence of having been tightly cemented with silica during the diagenetic stage; 95% of some measured sections display this. Some of the finest examples of orthoquartzites occur in the thick geosynclinal pile. Authigenic quartz is commonly present as doubly-terminated prisms in many of the strata.

Regional studies suggest that the sources for the abundant siliceous material were not only peripheral to the upper Paleozoic miogeosyncline, but within it as well. Volcanic archipelagoes to the W. provided much siliceous material directly to the marine waters as ash and other effusives, and indirectly from weathering and erosion of the terrestrial accumulations of lava. Land masses within the geosyncline furnished silica attendant upon removal of sedimentary and crystalline material. Cratonic areas marginal to the geosyncline, particularly those which lay to the SE., E., and NE. undoubtedly comprised important provenances for additional silica. Investigations of the siliceous materials require combinations of field and laboratory techniques; the latter involve studies of thin sections, insoluble residues, chemical analyses, and cellulose peels. All are invaluable complements to evaluate correctly the conditions of sedimentation. --Auth.

1-1522. Bourcart, Jacques, and Roger H. Charlier. THE TANGUE, A "NONCONFORMING" SEDIMENT: Geol. Soc. America, Bull., v. 70, no. 5, p. 565-68, 2 figs., May 1959, 9 refs.

The tangue has been observed as a relatively shallow-water sediment along the French Atlantic coast, and especially in Brittany. It has a very high calcium carbonate content. The tangue was originally thought to be a recent deposit, but the discovery of considerable layers of old tangue made this original hypothesis untenable. Tangue beds are characterized by thin layers reminiscent of varves.

The tangue does not conform to the traditional deposit patterns inasmuch as, if one progresses seaward, the size distribution of grains is contrary to the distribution observed normally in other sediments. --Auth.

1-1523. Benson, Richard H. MODERN STUDIES OF RECENT MARINE SEDIMENTS: Compass, v. 36, no. 4, p. 289-95, fig., May 1959, 14 refs.

Geologists have long proclaimed that the present is the key to the past. Within the last 10 years improvements in devices and equipment for underwater exploration have made it possible for geologists to study processes in the sea more readily than ever before. While outer space offers a challenge to the daring and inventiveness of some, the ocean bottoms of the earth remain the closest, the most accessible and profitable of the last great unknown regions for future exploration. --Auth.

1-1524. Carr, Donald D. IMPORTANCE OF RECENT SEDIMENT STUDIES TO THE INTERPRETATION OF DEEP BASIN DEPOSITS: Compass, v. 36, no. 4, p. 310-18, 6 figs., May 1959, 9 refs.

Modern studies of Recent sediments may provide information that will indicate deep sea origin for sediments that are now differently classified.

It is difficult to obtain information on the deep oceans because of the expense involved and special equipment that is needed.

Bathyal and abyssal conditions exist in 2 distinct situations: the broad ocean basins and the mediterraneans. Illustrations are presented to show the different conditions that exist in deep sea basins. --Auth.

See also: Geochemistry 1-1465.

1-1525. Winterkorn, Hans F., ed. WATER AND ITS CONDUCTION IN SOILS, AN INTERNATIONAL SYMPOSIUM: Natl. Acad. Sci.-Natl. Research Council, Pub. 629; Highway Research Board, Spec. Rept. 40, 338 p., illus., diags., graphs, tables, 1958.

Contents: Introductory remarks, by Hans F. Winterkorn; Properties of water substance, by Worth H. Rodebush and Arthur M. Buswell; Water structure and bioenergetics, by Albert Szent-Györgyi; Organization of water on clay mineral surfaces and its implications for the properties of clay-water systems, by Ralph E. Grim; Influence of liquid and clay mineral type on consolidation of clay-liquid systems, by Walter C. Waidelich; Mechanism of moisture equilibrium and migration in soils, by B. V. Derjaguin and N. K. Melnikova; Movement and equilibrium of water in soil systems as affected by soil-water forces, by Philip F. Low; Influence of surface forces on flow of fluids through capillary systems, by E. A. Flood; Mechanism of soil moisture extraction from a pressure-membrane apparatus, by Hitoshi Fukuda; Mathematics of isothermal water conduction in unsaturated soil, by W. R. Gardner; Soil water movement in the film and vapor phase under the influence of evapotranspiration, by M. Hallaire; On the correlation of heat and moisture properties of soils, by F. E. Kolyasev and A. I. Gupalo; Moisture flow induced by thermal gradients within unsaturated soils, by W. L. Hutcheon; On the mechanism by which water moves through a porous material subjected to a temperature gradient, by J. M. Kuzmak and P. J. Sereda; Physics of water movement in porous solids, by J. R. Philip; Water movement in soils under pressure potentials, by Werner E. Schmid; Some concepts pertaining to the freezing soil systems, by Alfreds R. Jumikis; Pressures developed in a porous granular system as a result of ice segregation, by Edward Penner; Importance of water in formation of soil structure, by W. Czeratzki and H. Frese; Effect of water movement on soil, by Edward S. Barber; Movement and distribution of water in soil in relation to highway design and performance, by D. Croney, J. D. Coleman, and W. P. M. Black; Field studies on subgrade moisture conditions, by John W. Guinnee; Moisture content and the CBR method of design, by F. L. D. Wooltorton; Hydrophobic earth as a means of moisture-, thermal-, and electric-insulation, by F. K. Kolyasev and A. G. Holodov; Flow of water in hardened portland cement paste, by T. C. Powers, H. M. Mann, and L. E. Copeland; Mass transport phenomena in moist porous systems as viewed from the thermodynamics of irreversible processes, by Hans F. Winterkorn.

1-1526. Jaeger, J. C. THE ANALYSIS OF AQUIFER TEST DATA OR THERMAL CONDUCTIVITY MEASUREMENTS WHICH USE A LINE SOURCE: Jour. Geophys. Research, v. 64, no. 5, p. 561-64, 2 figs., 2 tables, May 1959, 4 refs.

A simple numerical method for analyzing observations of drawdown in the neighborhood of a pumped well is described. It makes use of the ratio of the values of the drawdown at any 2 times, and a graph computed from the theory. It has the advantage over existing procedures in that it is available for the analysis of isolated results and for small values of the time. The same method is applicable to the determination of thermal conductivity and practical examples of both cases are given. --Auth.

1-1527. Maasland, Marinus. WATER TABLE FLUCTUATIONS INDUCED BY INTERMITTENT RECHARGE: Jour. Geophys. Research, v. 64, no. 5, p. 549-59, 5 figs., May 1959, 17 refs.

The problem of water table fluctuations in response to repeated recharges is considered. The effect on the water table of intermittent constant recharge (recharge applied intermittently at a constant rate) and of intermittent instantaneous recharge (recharge applied instantaneously at regular intervals) is analyzed in detail. The final results are shown to consist of a combination of periodic and transient components; the transients are monotonic decreasing functions.

The theory may be applied to problems of groundwater flow through aquifers and to land drainage problems--Auth.

1-1528. Suter, Max, Robert E. Bergstrom, H. F. Smith, Grover H. Emrich, W. Clarence Walton, and Thurston E. Larson. PRELIMINARY REPORT ON GROUND-WATER RESOURCES OF THE CHICAGO REGION, ILLINOIS: Illinois, State Water Survey-Illinois, State Geol. Survey, Coop. Ground-Water Rept. 1, 89 p., 50 figs. incl. maps, secs., graphs, 26 tables, 1959, 40 refs.

The purpose of this study was to make an evaluation of the ground-water resources of the Chicago region on the basis of available data. Such an evaluation is particularly urgent at this time due to the progressively increasing demands for water supplies and the continuing decline of water levels in some aquifers.

Ground-water resources in the Chicago region of Illinois are developed from 4 water-yielding units: 1) glacial drift aquifers; 2) shallow dolomite aquifers; 3) Cambrian-Ordovician aquifer; and 4) the Mt. Simon aquifer.

The Cambrian-Ordovician aquifer has been the most highly developed source of large ground-water supplies. Its estimated yield in 1958 of more than 43 million gallons a day (m. g. d.) approaches the amount that can be withdrawn without dewatering the Ironton-Galesville sandstone, the lowermost and most productive formation in the aquifer. Artesian pressure in the Cambrian-Ordovician aquifer at Chicago has declined as much as 660 ft. since 1864 as a result of pumpage.

The glacial drift and shallow dolomite aquifers yielded more than half of the 127.9 m. g. d. of ground water pumped in the region in 1957. This withdrawal resulted in no general decline in nonpumping water levels, indicating that the potential yield is considerably larger than present withdrawal. Future ground-water supplies should be taken from the shallow aquifers wherever possible. --Auth.

1-1529. Suter, Max, Robert E. Bergstrom, H. F. Smith, Grover H. Emrich, W. Clarence Walton, and Thurston E. Larson. SUMMARY: PRELIMINARY REPORT ON GROUND-WATER RESOURCES OF THE CHICAGO REGION, ILLINOIS: Illinois, State Water Survey-Illinois, State Geol. Survey, Coop. Ground-Water Rept. 1-S, 18 p., 4 figs. incl. map, chart, secs., graph, 1959.

This report is a summary of the essential findings

of Cooperative Ground-Water Report 1 [see above] issued by the [Illinois] State Water Survey and the [Illinois] State Geological Survey. Report 1 discusses the geology and hydrology of the ground-water resources of the Chicago region, along with the history, present conditions, and effects of possible future development. Special emphasis is placed on the deep water-yielding formations, or aquifers, which have been most widely used for large ground-water supplies. Basic geologic, hydrologic, and chemical data applicable to local problems and to regional and long-range interpretations are presented to help formulate future policies regarding planning and development of water resources in northeastern Illinois. --Auth.

1-1530. Bayne, Charles K., and Kenneth L. Walters. GEOLOGY AND GROUND-WATER RESOURCES OF CLOUD COUNTY, KANSAS; WITH A SECTION ON CERAMIC MATERIALS, by Norman Plummer: Kansas, State Geol. Survey, Bull. 139, 144 p., 21 figs., 3 pls. (in pocket), incl. geol. map, water map, secs., 16 tables, 1959, 21 refs.

This report describes the geography, geology, and ground-water resources. Data include records of 170 wells, chemical analyses of water from 57 representative wells, and logs of 76 test holes. In addition, 100 holes were augered to determine the depth to water.

The rocks that crop out in Cloud County are sedimentary and range in age from Cretaceous to Recent. The oldest formation exposed in the county is the Dakota formation. The youngest Cretaceous formation exposed in the county is the Carlile shale. The Ogallala formation, of Tertiary age, is present as small remnants in a few places. The Cretaceous rocks are mantled in many places by unconsolidated continental deposits of fluviatile and eolian origin representating 4 stages of the Pleistocene epoch.

The unconsolidated sand and gravel deposits of Pleistocene age form the principal aquifers in the county. These deposits are best developed in the valley of Republican River. The Dakota formation yields moderate quantities of water, but Cretaceous rocks overlying the Dakota formation yield very little water in the county. Where it is deeply buried the Dakota formation contains salty water, which is being discharged into the valley fill of Republican River near Concordia.

Ground water in the area is recharged principally from local precipitation; underflow from adjacent areas contributes significantly, however. Ground water is discharged mainly by seepage into streams and by transpiration by plants; there is some discharge by underflow across the eastern boundary of the county. All municipal and industrial water supplies and most domestic and stock supplies are obtained from wells. Irrigation from wells is practiced extensively in the valley of Republican River, and to a lesser extent in the Solomon River valley. --From auth. abs.

1-1531. Winograd, I. J. GROUND-WATER CONDITIONS AND GEOLOGY OF SUNSHINE VALLEY AND WESTERN TAOS COUNTY, NEW MEXICO: New Mexico, State Engineer Office, Tech. Rept. no. 12, 70 p., 11 figs. incl. illus., fold. geol. and water-table contour maps, fold. sec., 7 tables, 1959, 19 refs.

The report describes the occurrence and availability of ground water, in relation to the geology, in Sunshine Valley, in N.-central Taos County, and under a vast lava-capped plateau which constitutes Taos County S. of the Rio Grande. The study upon which the report is based was made by the U. S. Geological Survey in cooperation with the New Mexico State Engineer. It was directed primarily toward a determination of the availability of ground water in Sunshine Valley for irrigation, and to determine what effect, if any, heavy withdrawals of ground water in the valley would have upon the accretion of ground water to the Rio Grande and the Red River, a tributary.

Physiographically, the region falls within the Southern Rocky Mountain province, which in New Mexico consists of 2 highland prongs, the Conejos and Jemez mountains and Sierra Nacimiento on the W. and the Sangre de Cristo Mountains on the E. bordering a basin. In Taos County this basin, called the Rio Grande trough, consists of a vast lava-capped plateau W. of the Rio Grande and of piedmont alluvial plains E. of the river. The Rio Grande flows through the trough in a picturesque canyon cut into the lava flows which form the plateau. The eastern boundary of the trough is sharply delineated by the bold western face of the Sangre de Cristo Mountains. The western edge of the trough is less well defined, as the lava-capped plateau, which forms the western two-thirds of the trough, rises gradually toward the Conejos Mountains.

This basin-and-range structure is believed to have originated in late Tertiary time, and to have been periodically rejuvenated by either intermittent uplift or depression of the basin. E. of Sunshine Valley the Sangre de Cristo Mountains have been uplifted at least 7,000 ft. and tilted eastward since Pliocene time. Continued uplift is indicated by fault scarplets in unconsolidated sediments at the western base of these mountains. The materials deposited in the Rio Grande trough consist of alluvial sediments and andesite-basalt lava flows, which together compose the Santa Fe group. The deposition of alluvial sediments derived from the highlands was dominant at first, but, in later large-scale volcanic activity, lavas exceeding 600 ft. in aggregate thickness were spread over wide areas. Thus was created the lava-capped plateau which forms the western two-thirds of the Rio Grande trough in Taos County. Interbedded lava and alluvial sediments which occur beneath Sunshine Valley and are visible in the Rio Grande Canyon at Dunn Bridge testify to the intermittent nature of the volcanism. After the last period of volcanic activity the eastern extremity of the plateau was buried beneath alluvial sediments which compose the piedmont alluvial plains lying at the base of the Sangre de Cristo Mountains. Sunshine Valley is one of these piedmont alluvial plains. The structure of the rocks older than late Tertiary that were downfaulted into the trough is completely masked by the rocks of the overlying Santa Fe group. Several hills of Precambrian and middle Tertiary rocks protrude above the surface of the plateau and possibly are indicative of some splinter faulting within the trough.

The Santa Fe group, of middle(?) Miocene to Pleistocene(?) age, is the major aquifer in the region. Beneath the plateau, both the andesite-basalt and the alluvial sediments furnish an adequate supply of moderately hard water for domestic and stock use. The water is encountered under water-table conditions at depths of about 250 to 750 ft. beneath the surface, although some perched water bodies, yielding an intermittent water supply, are found at shallow depths along arroyo courses.

In Sunshine Valley, wells yielding 600 to 3,000 gallons of water per minute (g. p. m.) have been developed in the alluvial sediments for irrigation. The static nonpumping levels in the irrigation wells range from 18 to 271 ft. below the surface, the specific capacities of the wells generally being less than 20 g. p.m. per foot of drawdown. The quality of the water is satisfactory for irrigation. In the western half of the valley the alluvial sediments cover and are interbedded with lava. Several of the deep irrigation wells have penetrated the lava. In general, the lava has not been tapped for irrigation water, owing to the availability of water at shallower depths within the alluvial sediments and owing also to the great depth to water in the lava where it is not overlain by alluvial sediments. Where the alluvial sediments cover and are interbedded with lava, ground water in the sediments is semi-perched with respect to the water in the underlying andesite-basalt, primarily because of the low permeability of the alluvial sediments relative to the permeability of the lavas which transmit water through fractures and interflow zones under very low gradients. Because of the lower head of water in the lava, water commonly is heard cascading into wells that penetrate this rock where the rock is overlain with saturated sediments. Improperly constructed wells that allow water in the alluvial sediments to drain to the underlying lava will cause additional lowering of water levels in the sediments and possibly cause their depletion. For least wasteful development both aquifers should not be tapped in the same well.

Alluvium of Recent age furnishes water to dug wells along Costilla Creek in the NE. corner of the valley. Although the Precambrian granite furnishes an intermittent supply of water to wells at Tres Piedras, the Precambrian and middle Tertiary rocks which border the valley on the E. and protrude above the plateau surface are in general non-water-bearing. Wells drilled into the Santa Fe group adjacent to these rocks probably will not furnish an adequate water supply if the Precambrian and middle Tertiary rocks are above the elevation of the regional water table in the Santa Fe group.

Within the region studied, between the Colorado-New Mexico state line and the Red River, the Rio Grande gains about 96 cu. ft. per second (c.f. s.), or about 70,000 acre-ft. annually, from ground-water accretion. Between 1948 and 1955 the annual accretion ranged from 10 to 55% of the flow in the river immediately upstream from Red River. During periods of low flow this accretion at times has exceeded 90% of the flow at the Cerro gaging station opposite the the southwestern corner of the valley. The Red River, which bounds the area studied on the SE., gains about 33 c. f. s. from ground-water flow, of which probably at least half or about 12,000 acre-ft. a year originates from the area investigated. A water-table contour map indicates that the 112 (96 + 16) c. f. s. of accretion is derived from the ground-water reservoirs beneath Sunshine Valley E. of the river, from the lava-capped plateau W. of the river, and also from rocks of the Santa Fe group in Colorado. It is estimated that about a fourth of this accretion is from Sunshine Valley.

Pumping from rocks of the Santa Fe group in Sunshine Valley upsets the equilibrium that existed between recharge and discharge from this aquifer under natural conditions and tends to establish a new equilibrium in which there is either a reduction in the natural discharge, an increase in the natural recharge, or both, in an amount equal to the pumpage. However, the aquifer is absorbing practically all the water available to it as recharge and thus pumping cannot affect the rate of recharge. Therefore, pumping from rocks of the Santa Fe group in Sunshine Valley for irrigation will eventually reduce ground-water accretion to the Rio Grande by an amount equal to the consumptive use. Total ground-water pumpage in Sunshine Valley in 1955 was estimated to be 3,500 acre-ft. ; the part of this that was consumptively used is not known. The total pumpage was equivalent to about 5% of the total accretion of ground water to the river.

Owing to the relatively high permeability of the lava through which water from the alluvial sediments passes before discharging to the Rio Grande, a reduction in head within the overlying alluvial sediments by pumping may affect accretion to the river within a relatively short time. --Auth.

1-1532. Perlmutter, Nathaniel M., James J. Geraghty, and Joseph E. Upson. THE RELATION BETWEEN FRESH AND SALTY GROUND WATER IN SOUTHERN NASSAU AND SOUTHEASTERN QUEENS COUNTIES, LONG ISLAND, NEW YORK: Econ. Geology, v. 54, no. 3, p. 416-35, 7 figs. incl. map, secs., table, May 1959, 5 refs.

An investigation of the geology and ground-water conditions in a part of southwestern Long Island, including the construction of 8 deep and 5 shallow test and observation wells, has been completed by the U. S. Geological Survey in cooperation with the Nassau County Dept. of Public Works and the New York State Water Power and Control Commission.

In this area are 4 main water-bearing units of Late Cretaceous and Pleistocene age Ground water having a higher than normal salt content is encountered in some wells that penetrate the upper 3 units. Although the presence of this water constitutes a potential threat, existing fresh-water supplies apparently are in little immediate danger under present conditions.

The "salty" ground water has chloride concentrations ranging from about 40 to 18,000 p. p. m. (parts per million), generally more than about 2,000 p. p. m. It occurs in several bodies, seaward of and beneath the fresh water in the respective aquifers, and is in contact with the fresh water through zones of diffusion. The largest salt-water body, confined under artesian pressure, is in the Jameco gravel and the Magothy(?) formation beneath extreme southwestern Nassau County and adjoining southeastern Queens County. This body is thought to have occupied a substantial part of its present extent since at least 1895. It probably has been and is now encroaching, very slowly, because of increased pumping from the fresh-water bodies and possibly as a result of a postglacial rise of sea level. The rate of encroachment under present conditions probably is less than 100 ft. per year.

Application of the Ghyben-Herzberg principle to compute depths to the contact between salty and fresh ground water was found to give erroneous results. More accurate depths and a clearer understanding of the relation between heads in adjoining bodies of fresh and salty ground water are obtained by use of a formula adapted from one given by M. King Hubbert. --Auth.

1-1533. Brown, Philip Monroe. WELL LOGS FROM THE COASTAL PLAIN OF NORTH CARO-

LINA: North Carolina Dept. Conserv. & Devel., Div. Mineral Resources, Bull. 72, 96 p., 8 pls., map, 8 cross secs., correlation chart, 1958, 36 refs.

This bulletin contains the logs of 82 wells. The logs classify the rock materials by percentages of major constituents and record some of the diagnostic Ostracoda from the formations penetrated. The purposes of the bulletin are to correlate subsurface information so that lithologic composition and geographic extent of water-bearing formations can be determined in areas where ground-water studies are being made, make available to well drillers and prospective well owners information about the depth and lithologic properties of the various water-bearing beds, and present recent information on the subsurface stratigraphy of the Coastal Plain of North Carolina. This bulletin contains the best information on the subsurface stratigraphy and water-bearing quality of the beds in the Coastal Plain of North Carolina presently available. --J. L. Stuckey.

1-1534. Gilbert, C. R. HYDROLOGIC AND PHYSICAL DATA FOR SANDSTONE CREEK WATERSHED IN WESTERN OKLAHOMA, 1951-56, prepared cooperatively by U. S. Geological Survey, U. S. Soil Conservation Service, and the Oklahoma Water Resources Board: Oklahoma Water Resources Board, Bull. 17, 124 p., 55 figs. incl. maps, graphs, 10 tables, 1959.

The specific objective of the data-collection program reported herein is to supply basic data needed for the application of improved methods of hydrologic analysis in the development of program plans. The data collected will be useful as a basis for evaluating the efficacy of the flood-prevention measures as installed and applied on this particular watershed and their effect on regimen of main stream to which the area is tributary, with respect to both flood flows and water yield. Data will be useful also in the planning and design of other hydraulic works such as bridges and culverts, small municipal water supplies, irrigation, and recreation lakes. --From auth. introd.

The watershed project area is located in Beckham and Roger Mills counties and covers about 107 sq. mi., including 3 major tributaries - Currant Creek, Wildcat Creek, and East Branch Sandstone Creek. Climate, geology, soils, land use and cover are briefly described. The report consists primarily of precipitation, runoff, and storage data for the various sections of the watershed.

12. MINERAL DEPOSITS

See also: Geologic Maps 1-1329 through 1-1335; Areal and Regional Geology 1-1363, 1-1365; Structural Geology 1-1377; Geochemistry 1-1451, 1-1467; Mineralogy 1-1472, 1-1498.

1-1535. Alvarez, Manuel, Jr. BASES CIENTIFICAS DE LA EXPLORACION MINERA [THE SCIENTIFIC FOUNDATIONS OF MINERAL EXPLORATION]: Soc. Geol. Mexicana, Bol., v. 21, no. 1, p. 67-82, 1958.

The object of this article is to show the necessity for Mexico to conduct regional geologic investigations, which will serve as a scientific foundation for the exploration of mineral resources and afterwards for estimating the reserves.

The geologic investigations which must be made are briefly described, so that on their basis other studies of an economic character, also regional, may be effected, which will serve to establish criteria for estimating the mineral resources and to produce efficiently systematic and specific exploration for minerals.

The general geologic studies which are considered necessary on which to base scientifically the economic investigations, are: the geologic history of the physiographic provinces, the epochs and petrographic provinces, and the regional tectonics.

In the following pages it is briefly mentioned what these concepts consist of, and afterwards those of regional economic character based on the former, such as the geologic setting and physiographic relations of the mineral deposits, the metallogenetic provinces, and minerals associated with the mineral deposits, the systems of faults and fractures and their relation with the mineral deposits, and the contacts and relative age of the faults and fractures and their relation with the mineralization.

Afterwards the methods used in mineral exploration are mentioned, giving an example of one of them, and finally comments are made on the role played by the prospector, the mining engineer, and the geologist in mineral exploration. --Auth. (transl.)

1-1536. Carlisle, Donald, and George B. Cleveland. PLANTS AS A GUIDE TO MINERALIZATION: California, Div. Mines, Spec. Rept. 50, 31 p., illus., geol. maps, 1958, approx. 190 refs.

A buried mineral deposit may be detected, under favorable conditions, by the recognition of abnormally high concentrations of metal in plants growing above the deposit. Numerous factors other than the metal content of the soil influence the metal content of plants, and therefore biogeochemical data can be misleading.

This paper contains a review of data (soil science, horticultural and geological) bearing on the influence of the plant, the environment of the plant, the physical and chemical state of the metal, and the physical and chemical properties of the soil, on metal uptake. Metal uptake is controlled mostly by the chemical properties of the soil, and to a lesser degree by soil moisture and drainage. Metal content of plants is influenced by kind and concentration of exchange materials and other ions, by pH, and by organic materials in the soil.

Plants growing in 3 widely separated Mo-bearing areas in California were found to contain abnormally high concentrations of Mo. The bedrock, which is different in each of the areas, may partly control the Mo concentration in the plants through its influence on soil chemistry. The detection of differences in Mo concentration of plants that were growing above a fault zone, indicated an irregular pattern of mineralization in the underlying bedrock. In one area, where the soil was analyzed, the Mo concentration in the plants is greater than in the soil. W ore was discovered subsequently in the bedrock beneath an area where plants are abnormally rich in Mo. --California Div. Mines.

1-1537. Volobuyev, V. M. EXPERIMENTAL APPLICATION OF METALLOMETRY IN EXPLORATION FOR VEIN-DISSEMINATED (PORPHYRY) TYPE

COPPER DEPOSITS IN CENTRAL KAZAKHSTAN. Translated by K. D. Solovieff and William D. Romey: Internat. Geology Rev., v. 1, no. 3, p. 31-33, March 1959, 2 refs.

Among methods of prospecting for Cu deposits is the simple metallometric (geochemical) survey, which was used in central Kazakhstan, U. S. S. R. Cu dispersion halos were plotted on a grid, and anomalously high Cu concentrations studied in more detail. This consisted of sampling, spectrographic analysis, and chemical analysis. One or 2 holes are drilled to locate zones of secondary sulfide enrichment and primary ore after examination of the bedrock and determination of geological structure. The results obtained give an idea of the size of the oxidized zone, secondary sulfide enrichment zones, and the Cu content. --G. E. Denegar.

1-1538. Molly, E. W. PLATINUM DEPOSITS OF ETHIOPIA: Econ. Geology, v. 54, no. 3, p. 467-77, 2 maps, May 1959, 7 refs.

The Pt deposit of Yubdo (Wallaga province), in western Ethiopia, is of the same type of those of the Urals. It shows a dunitic core surrounded concentrically by pyroxenites and by gabbros. This arrangement of increasing basic character toward the center is typical of the Urals deposits.

The Yubdo deposit, however, shows one particular feature, the capping of the dunites by "birbirites" which consist essentially of secondary silica and limonite, and are derived from the dunites through alteration and concentration processes.

The primary mineralization is not mined because of the very low Pt content of the dunites and birbirites. The capping eluvium has been worked for the past 30 years in a fairly primitive fashion, and it is largely exhausted. On the other hand, the alluvium of the present and of former beds of the Birbir river, occurring downstream from the deposit, and which have been left intact because of their position below the hydrostatic level, seems to offer fairly notable possibilities. --Auth.

1-1539. Sater, G. S., comp. PRELIMINARY REPORT ON THE LEAD AND ZINC DEPOSITS OF THE PROVINCE OF QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 371, 41 p., 1958, 76 refs.

The Province of Quebec provides a substantial part of Canadian production of Zn and a smaller proportion of the Pb output. Pb and Zn occurrences are numerous and widely distributed. In most occurrences galena and sphalerite are found together, sphalerite commonly more abundant than galena. Some deposits, particularly those of northwestern Quebec were formed at high temperature; others, notably in the St. Lawrence lowlands and Lemieux Township, are low-temperature type. Some of the larger deposits are of the replacement type; others are made up of veins where the minerals were introduced into open fissures. Production of Pb and Zn in Quebec in 1956 totalled 5,745,615 lbs. of Pb, valued at $891,145, and 171,945,511 lbs. of Zn, valued at $25,516,714.

The great majority of known occurrences in Quebec are listed in this report and briefly described to indicate the character of the mineralization. Occurrences are listed by townships, seigneuries, and regions, each in alphabetical order. Lots listed in the subtitles are those in which the main deposit occurs or in which the principal mine workings are situated. Names of mines and mining companies are correct for the date on which the report was made. An alphabetical index of occurrences identified by names is provided. --From auth. introd.

1-1540. Nishihara, Hironao. ORIGEN DE LOS YACIMIENTOS CUPRIFEROS EN MANTOS EN BAJA CALIFORNIA, MEXICO [ORIGIN OF THE "MANTA" COPPER DEPOSITS IN LOWER CALIFORNIA, MEXICO]: Soc. Geol. Mexicana, Bol., v. 21, no. 1, p. 95-110, 1958, 25 refs.

Spanish translation of article originally published in Economic Geology, v. 52, no. 8, Dec. 1957 (see Geological Abstracts, v. 5, no. 4, p. 23, Dec. 1957).

1-1541. Alvarez, Manuel, Jr. CONSIDERACIONES GENERALES SOBRE DEPOSITOS DE URANIO [GENERAL CONSIDERATIONS ON URANIUM DEPOSITS]: Soc. Geol. Mexicana, Bol., v. 21, no. 1, p. 43-65, 1958, 11 refs.

This is a general review of the uraniferous deposits of the United States and the Belgian Congo, and of the U minerals which are found. The author classifies the deposits as follows:

A. Deposits in igneous and metamorphic rocks
   a. hydrothermal vein deposits
   b. disseminated deposits in igneous rocks
   c. pegmatites
B. Deposits in sedimentary rocks
   a. deposits of carnotite
   b. Cu-U deposits
   c. deposits of U in asphalt
   d. deposits of U in limestone
   e. deposits of U in phosphorites
   f. deposits of U in black shales
   g. alluvial deposits and placers
   h. lacustrine salt deposits

Under each of these headings a short description is given of known deposits. --R. van Vloten.

1-1542. Bates, Robert C. AN APPLICATION OF STATISTICAL ANALYSIS TO EXPLORATION FOR URANIUM ON THE COLORADO PLATEAU: Econ. Geology, v. 54, no. 3, p. 449-66, 13 maps, 2 tables, May 1959, 14 refs.

The literature on the Colorado Plateau U-V deposits before 1944 includes many geologic factors that could have influenced the deposition of the U and V ore-minerals. Maps are drawn showing the relationships between these influencing geologic factors and the ore deposits, and the data on these maps transferred, using a grid system, to record sheets. These data are then ranked and analyzed using Spearman's coefficient of rank correlation. The units of the subdivided geologic factors that gave significantly positive correlations with the productivity of the deposits are combined graphically to show the most favorable areas. Deposits that were discovered after 1944 are compared to the outlined favorable areas to show the validity of this type of analysis as a mineral exploration tool.

A little less than 78% of the U-V deposits on the Colorado Plateau that were discovered in the lower part of the Morrison formation after the analysis period (pre-1944) were inside of the areas outlined by the analysis as favorable. This suggests strongly that the statistical analysis can be used as a mineral exploration tool to outline areas favorable for ore deposits. --Auth.

1-1543. Shawe, Daniel R., Norbert L. Archbold, and George C. Simmons. GEOLOGY AND URANIUM-VANADIUM DEPOSITS OF THE SLICK ROCK DISTRICT, SAN MIGUEL AND DOLORES COUNTIES, COLORADO: Econ. Geology, v. 54, no. 3, p. 395-415, 9 figs. incl. 3 maps, drill logs, secs., table, May 1959, 10 refs.

Previously published in: International Conference on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proceedings, v. 2, Survey of Raw Material Resources. It is listed as GeoScience Abstracts 1-1000.

1-1544. Davidson, Edward S. GEOLOGY OF THE RAINY DAY URANIUM MINE, GARFIELD COUNTY, UTAH: Econ. Geology, v. 54, no. 3, p. 436-48, 5 figs. incl. 2 maps, May 1959, 14 refs.

The Rainy Day mine, in the Circle Cliffs area, Utah, is developed on a long slender pod of U ore. Ore is localized in siltstone of the Moenkopi formation of Triassic age, on the S. edge of a channel about 3,300 ft. wide by 40 ft. deep that is filled with sandstone of the Shinarump member of the Chinle formation of Triassic age. Shale of the Chinle rests directly on siltstone of the Moenkopi on either side of the channel. The pod of ore is of moderately high grade, 1 1/2 by 4 ft. in cross section, and is continuous for a mined distance of more than 1,800 ft. Sphalerite, chalcopyrite, pyrite, marcasite, and galena are associated with a black U mineral, which is probably uraninite. Semiquantitative spectrographic analyses show that Pb, Cu, Ni, Co, Ag, Mo, Zn, Y, and Yb increase proportionately with U; the increase suggests that these metals were introduced by the ore-forming fluid.

The deposit is on the E. flank of the NW.-trending Circle Cliffs anticline. No major faults are near the mine, nor were any through-going joints noted in the deposit. Efforts to correlate the localization of the deposit with minor structures were unsuccessful. --Auth.

1-1545. Haines, David V. CORE LOGS FROM SEARLES LAKE, SAN BERNARDINO COUNTY, CALIFORNIA: U. S. Geol. Survey, Bull. 1045-E, p. 139-317, 8 illus. (4 in pocket), May 1959, 14 refs.

Forty-one drill holes in the saline deposit on Searles Lake, San Bernardino County, California, were cored and logged. Drill holes averaged about 100 ft. in depth; the majority are located around the margins of the dry lake. The saline deposit consists of an upper salt body about 39 sq. mi. in area, of which 12 sq. mi. are exposed in the central part of the lake, and a lower salt body of approximately the same areal extent found at greater depth. The 2 salt bodies are separated by a seam of clay or marl averaging about 12 ft. thick. Isopach maps show the salt bodies are slightly elongated to the N.; maximum thicknesses of the upper and lower salt bodies are 95 and 54 ft., respectively. Core logs, in written and graphic form, show the chief minerals of the saline bodies are halite, trona, hanksite, borax, and burkeite; relatively minor quantities of 13 additional minerals are described. The 41 drill-hole logs are shown graphically in columnar sections which give thicknesses, mineralogy, and mineral percentages; 15 representative written logs are published in full. --Auth.

1-1546. Patton, William W., Jr., and John J. Matzko. PHOSPHATE DEPOSITS IN NORTHERN ALASKA: U. S. Geol. Survey, Prof. Paper 302-A, 17 p., 9 illus. (4 in pocket), May 1959, 13 refs.

Deposits of sedimentary phosphate rock were discovered on the Arctic Slope of Alaska during the geologic investigation of Naval Petroleum Reserve No. 4 between 1944 and 1953. They occur in at least 2 stratigraphic units, the Lisburne group (Mississippian) and the Shublik formation (Triassic), and have been found at widely scattered localities along the N. front of the Brooks Range and in the adjoining foothills. The deposits in the Lisburne group in the central Brooks Range and Arctic foothills are of principal interest and have been examined in detail and systematically sampled at 2 localities, Tiglukpuk Creek and upper Kiruktagiak River.

The Tiglukpuk Creek and upper Kiruktagiak River areas are underlain by a thick sequence of highly deformed sedimentary rocks including the Wachsmuth limestone and Alapah limestone of the Lisburne group (Mississippian), the Siksikpuk formation (Permian?), the Shublik formation (Triassic), and the Tiglukpuk formation (Jurassic). The phosphate deposits are confined to the black chert and shale member of the Alapah limestone, near the top of the Lisburne group. This member, which ranges from about 40 to 100 ft. in thickness, consists chiefly of dark shaly limestone, mudstone, and phosphate rock; it forms a distinctive lithologic unit within the massive light-colored fossiliferous clastic limestone that comprises the bulk of the Lisburne group which ranges in thickness from 2,000 to 2,500 ft.

The uraniferous phosphate rock from northern Alaska contains carbonate-fluorapatite as the phosphate mineral and, in general, is similar in mineralogy, phosphate, U, and minor element content to phosphates from the Phosphoria formation of Permian age in northwestern United States. Other minerals identified are calcite, dolomite, quartz, and purple and colorless fluorite. Carbonaceous matter stains all the phosphate rock.

In the Tiglukpuk Creek area the phosphatic zone in the black chert and shale member is 36 ft. thick and averages 8% P_2O_5. A 43-in. sequence of rock 16 ft. below the top of the zone averages 21% P_2O_5. In the upper 20 ft. of the zone, 6 beds, from 1 to 5.5 in. thick, contain 30% P_2O_5. In the upper Kiruktagiak River area the phosphate zone is 38 ft. thick and averages 12% P_2O_5. The upper 19 ft. averages 19% P_2O_5; one 27-in. sequence of rock 16 ft. below the top contains 27% P_2O_5. Because of the marked lateral variation in lithologic character and phosphate content in the black chert and shale member and the complex structure of the central Brooks Range and Arctic foothills, much work remains to be done before the phosphate deposits can be fully evaluated.

Samples containing as much as 35.8% P_2O_5 have been collected from the Shublik formation at several localities in the eastern Brooks Range. These deposits have not been sampled and measured systematically; therefore nothing is known of their thickness and extent. --Auth.

1-1547. McGrain, Preston, and Thomas J. Crawford. HIGH-SILICA SANDSTONE AND CONGLOMERATE ON PINE MOUNTAIN NEAR ELKHORN CITY, KENTUCKY: Kentucky Geol. Survey, Inf. Circ. 1, Ser. 10, 5 p., fig., 1959, 2 refs.

Pennsylvanian Lee sandstones and conglomerate form the crest of Pine Mountain. In the vicinity of Elkhorn City the material is unusually free of im-

purities; analysis of 8 samples showed an average iron oxide content of 0.040%. Texturally, the material ranges from minus 200 mesh (Tyler) to pebbles exceeding 2 in. in diameter. The area is served by the Chesapeake and Ohio, and the Clinchfield railroads.

This reconnaissance investigation of the Elkhorn City deposit indicates that it warrants consideration from industry interested in high-silica material. --T. J. Crawford.

1-1548. McGregor, Duncan J. DIRECTORY OF SAND AND GRAVEL PRODUCERS IN INDIANA: Indiana, Geol. Survey, Directory 6, 53 p., 4 figs., 1958.

Geographic location, number of employees, products, daily capacity, shipping facilities, and other pertinent information are given for the producers of sand and gravel in Indiana. The geology of sand and gravel deposits is discussed briefly. --Auth.

1-1549. Archibald, G. M. DESCRIPTION OF MINING PROPERTIES VISITED DURING 1957 IN THE CHIBOUGAMAU, BACHELOR LAKE, AND WASWANIPI REGIONS, ABITIBI TERRITORY, ABITIBI-EAST ELECTORAL DISTRICT; AN OUTLINE OF GEOLOGY AND EXPLORATORY WORK: Quebec, Dept. Mines, Prelim. Rept. 388, 27 p., 3 maps, 1959, refs.

Descriptions are of properties which have not reached production stage; information concerning producing mines appears annually in the publication The Mining Industry of the Province of Quebec. Names of companies or property owners and descriptions of their holdings were correct at the date of the examination. Properties are listed alphabetically by township. Geology is briefly described in each case; also development work, assay results when available. References to published information on the described properties are given at the beginning of each description. Township maps at the end of the report show the boundaries of the various properties. An alphabetical index to names of companies or property owners is provided. --A. C. Sangree.

1-1550. Quebec (Province), Dept. of Mines. OUTLINE OF PROGRESS OF THE MINING INDUSTRY IN THE PROVINCE OF QUEBEC DURING THE YEAR 1958, by Edgar E. Bérubé: 10 p., 5 illus. on 4 pls., fold. map, table, Quebec, Queen's Printer, 1959.

Estimates of the mineral production of the Province of Quebec, in 1958, show a total value of $395,565,306, a decrease of nearly 12.2% below the 1957 level.

The metallic substances, as a group, have been the most seriously affected by the economic recession of 1958. Fe, Fe ore, and Mo are mainly responsible for this decrease in the value of production. Producers of these substances have received $38,591,042 less than they did in 1957.

In the industrial minerals group, asbestos and titanium dioxide brought $11,578,855 less than in 1957. This sum represents 95% of the decrease in the value of the production of industrial minerals.

Only building materials show a slight increase, and this is due to larger sales of clay products and of sand and gravel.

Despite the decline in the total value of production, the vigorous campaign of prospecting and mine development pursued by the industry, together with the emergence of new producers in each of the 3 groups of mineral substances, identifies the year 1958 as one of progress for the mining industry of the Province of Quebec.--Auth.

1-1551. Quebec (Province), Dept. of Mines. GENERAL REPORT OF THE MINISTER OF MINES OF THE PROVINCE OF QUEBEC FOR THE YEAR ENDING MARCH 31st, 1958: Its: Prelim. Rept. no. 378, 67 p., 2 maps, graph, 14 tables, 1958.

The value of the mineral production of the Province of Quebec amounted to $438,701,683 during the calendar year 1957. This total, subject to slight revisions, represents a decrease of 5.3% below the value for 1956. Lower prices for Cu, Pb, and Zn coupled with the most unfavorable discount on United States funds in 25 years, were the factors responsible for this slump. However, the above-mentioned factors did not affect the demand for industrial and building minerals. --Auth. introd.

Work of the Mining Operations Branch, Geological and Geological Surveys branches, Mineral Deposits Branch, Petroleum, Gas and Water Branch, Laboratories Branch, Drafting and Cartography Branch, Civil Engineering Branch, Secretariate, Division of Editing and Printing, and Library are outlined.

1-1552. Harrison, J. E., and John D. Wells. GEOLOGY AND ORE DEPOSITS OF THE CHICAGO CREEK AREA, CLEAR COUNTY, COLORADO: U. S. Geol. Survey, Prof. Paper 319, 92 p., 61 illus., (13 in pocket), geol. map scale 5 in. to 2500 ft., 15 tables, June 1959, 25 refs.

The Chicago Creek area, Clear Creek County, Colo., forms part of the Front Range mineral belt, which is a NE.-trending belt of coextensive porphyry intrusive rocks and hydrothermal veins of Tertiary age. More than $4.5 million worth of Au, Ag, Cu, Pb, Zn, and U was produced from the mines in the area between 1859 and 1954.

The bedrock in the area is Precambrian and consists of igneous rocks, some of which have been metamorphosed, and metasedimentary rocks. The metasedimentary rocks include biotite-quartz plagioclase gneiss that is locally garnetiferous sillimanitic biotite-quartz gneiss, amphibolite, and lime-silicate gneiss. Rocks that may be metasedimentary or metaigneous rocks are quartz monzonite gneiss and granite gneiss and pegmatite. The granite gneiss and pegmatite locally forms a migmatite with the biotitic metasedimentary rocks. These older rocks have been intruded by granodiorite, quartz diorite and associated hornblende, biotite-muscovite granite, and granite pegmatite. During Tertiary time the Precambrian rocks were invaded by dikes and plugs of quartz monzonite porphyry, alaskite porphyry, granite porphyry, monzonite porphyry, bostonite and garnetiferous bostonite porphyry, quartz bostonite porphyry, trachytic granite porphyry, and biotite-quartz latite porphyry. Solifluction debris of Wisconsin age forms sheets filling some of the high basins, covering some of the steep slopes, and filling parts of some of the valleys; talus and talus slides of Wisconsin age rest on, or are mixed with, solifluction debris in some of the high basins. Recent and/or Pleistocene alluvium is present along valley flats of the larger streams and gulches.

Two periods of Precambrian folding can be recog-

nized in the area. The older folding crumpled the metasedimentary rocks into a series of upright and overturned NNE.-plunging anticlines and synclines. Quartz monzonite gneiss, granite gneiss and pegmatite, granodiorite, and quartz diorite and associated hornblendite were metamorphosed during this period. The second period of folding appears to have been the reflection at depth of faulting nearer the surface; it resulted in crushing as well as some folding of the already folded rocks into terrace and monoclinal folds that plunge gently ENE. The biotite-muscovite granite, which is the youngest major Precambrian rock unit, is both concordant (phacolithic) and cross-cutting along the older fold system and has been fractured by the younger fold system.

Arching of the Front Range highland during Laramide time is believed responsible for the development of a regional joint pattern consisting of a NNW.-trending longitudinal joint, a related cross joint, and 2 related diagonal joints. Joints of this regional pattern can be distinguished from Precambrian and Tertiary joints. NW.-trending faults known as the "breccia reef" system, formed possibly during or following the arching. During Tertiary time the bedrock was intruded by porphyritic dike rocks that probably were emplaced under tensional stresses. Later regional shear stresses caused E.- to NNE.-trending fractures in the bedrock and at places reopened the "breccia reef" faults. These openings were the loci of deposition of hydrothermal veins.

The fractures formed under the regional shear stress are as much as 2 1/2 mi. long and are relatively straight fault fissures that follow the "grain" of the bedrock. Many faults are subparallel to foliation, axial planes of folds, contacts between rock units, or preexisting joints.

The veins in the district are typical mesothermal fillings of fault fissures. Some of the veins are lodes that have smooth bounding walls and abundant slickensides; the faults containing these veins are fairly regular in strike and dip, and irregularities, where present, commonly provided favorable structures for the deposition of the ore minerals.

A series of 5 vein types and 1 subtype can be recognized in the area. Most of these veins contain quartz, carbonate minerals, pyrite, chalcopyrite, tetrahedrite-tennantite, galena, and sphalerite, and many contain minor amounts of Au, Ag, or polybasite. The proportion of the metallic minerals in any vein is used as the basis for classifying the veins into types. The 5 vein types are (1) pyritic, (2) pyritic with copper sulfides, (3) pyritic galena-sphalerite with copper sulfides and copper and silver sulfosalts, (4) galena-sphalerite with pyrite and/or marcasite and copper and silver sulfosalts, and (5) galena-sphalerite. The subtype is similar to the pyritic type but is telluride bearing. Many veins are composite and contain 2 or more types of ore. Wherever composite veins have been observed, the older type of ore is always more pyritic than a younger type. The writers believe that the veins resulted from repeated fracturing, each fracture being filled at the time of opening by solutions that changed with time from predominantly Fe-depositing through Cu-depositing, to Pb-Zn-depositing.

Some of the veins, pegmatites, and porphyries of Tertiary age are abnormally radioactive. All the known occurrences in the porphyries are of too low grade to be important commercially. Most of the abnormally radioactive material in veins and pegmatites is either too low grade or in too small quantities to be of commercial importance. Some of the occurrences in veins have been explored inadequately and could not be evaluated in 1955.

Structural control of some of the ore shoots in the area is well defined. Openings favorable for the deposition of ore were formed at vein intersections, along deflections in strike or dip of veins, and along deflections where veins enter rocks of different competency.

About 60 mines are scattered throughout the area; they range in size from those containing a few hundred feet of workings to those containing several miles of workings Most of the mines have not been worked for years; many have not been worked since before 1900. During 1953, 1954, and the first half of 1955, only 1 mine was in continual operation, and only 3 others had a small amount of exploration work done in them. --Auth.

1-1553. Schoewe, Walter H. THE GEOGRAPHY OF KANSAS. PART IV. ECONOMIC GEOGRAPHY: MINERAL RESOURCES: Kansas Acad. Sci., Trans., v. 61, no. 4, p. 359-468, figs. 85-123, tables 32-71, Winter 1958, pub. 1959.

Mineral Resources, the fifth article of a series on the geography of Kansas, is a review of the mining industry of Kansas from about 1865 to 1956. The paper which brings under one cover for the first time all statistical data pertaining to the state's mineral commodities is well illustrated with many graphs, maps, and photographs and is replete with numerous tables listing annual mineral production and value of all minerals produced up to 1956. In addition to the statistical data the paper discusses the reserves of each mineral commodity, the historical development of the mineral resources, and includes numerous items of human interest associated with its early history.

Pertinent data reveals 1) that Kansas ranks among the upper 10 in the United States in mineral production; 2) that 27 minerals have been or are now being produced annually and 9 others are available but currently not being exploited; 3) that the mineral wealth has exceeded $400,000,000 annually since 1951 and more than $500,000,000 in 1956, an amount exceeding the average value of either the state's wheat crop, all other crops, livestock, or miscellaneous commodities produced in the same period of time.

Out of the 105 counties in the state each of the more than 50 counties produce minerals worth more than $1,000,000 annually, and 13 counties more than $10,000,000. Barton County, in which the value of annual production since 1950 has exceeded $40,000,000 is the leading Kansas producer. Kansas ranks fifth in the United States in oil, gas, and Zn production, third in value of salt, He, and carbon black produced, and seventh in natural gas liquids. Oil and gas have been or are being produced in 82 counties, sand and gravel in at least 75 counties, and stone in 41 counties. Coal, although mined in only 8 eastern Kansas counties in recent years, is known to occur and has been mined in at least 22 other eastern Kansas counties and in 10 in the N.-central part of the state. All metals mined, Pb and Zn, occur in Cherokee County in the southeastern part of the state.--Auth.

See also: Geologic Maps I-1324, I-1325, I-1326, I-1328; Areal and Regional Geology I-1355, I-1363; Stratigraphy I-1385, I-1386, I-1394; Mineralogy I-1492; Engineering Geology I-1575.

1-1554. Arnold, Ralph. PSEUDO EVIDENCES OF OIL AND GAS: Am. Assoc. Petroleum Geologists, v. 43, no. 5, p. 1058-1064, May 1959.

Pseudo evidences may be classified as natural and artificial, and the latter may be separated into accidental and intentional. Nature uses varied and sundry deceptive coloring and stains (black, brown, purple, and other colors) which simulate oil sands including sandstone "dikes" and "veins," limited lenses, and small inclusions of oil sands in surrounding barren material. In addition there are deposits of chemicals which one may mistake for oil deposits. In some instances, migrated or displaced oil has moved into reservoirs of porous igneous or other rocks which are normally incapable of acting as suitable traps for commercial deposits. Other gases or even air may act like petroleum gas in producing springs, water springs, mud volcanoes, and "blow-outs." Practically all of these types of misleading occurrences are of inorganic origin. However, there are rare cases of pseudo seepages caused by animals, insects, or vegetation. In places, a combination of inorganic and organic phenomena produces deceptive deposits, such as the reducing and precipitating action of decaying organic acids on the soluble Fe in marshes and other quiet waters.

Under the heading of accidental pseudo oil seepages and sands are the accidental injection of oil into porous sands or rocks from overturned railroad cars, trucks, or tanks, and a subsequent covering of the sands with mud or sand, which eventually were cut into by streams, erosion, or digging that exposed the sands as part of a series of beds. A leakage of oil down a drainage channel can produce the same results. The "discovery" of oil in water wells can usually be accounted for by oil which has been used in lubricating wind mills or pump machinery and which has trickled into the water.

Intentional false evidence of oil may be produced in several ways. Among the commonest is the pouring of oil into water wells or into the ground adjacent to water springs in such a way that the oil will gradually reach the water below the surface and emerge with the spring water. Another way is to saturate outcrops of porous sands or other beds with oil and later dig into the outcrop and expose the "oil sand." A third, and sometimes hard to detect method, is to pour oil into a drilling well, thus saturating penetrated sands, and then recovering cuttings or cores of "oil sand." Lubricating stuck casing or drilling equipment by pouring oil in the well produces the same effect, but without sinister motives. Oil injected into a wildcat well may ruin it for information purposes. --Auth.

1-1555. Meinschein, W. G. ORIGIN OF PETROLEUM: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 925-43, 3 graphs, table, May 1959, 28 refs.

Sediments and crude oils contain the same types of hydrocarbons. This analogy indicates that petroleum is derived from sedimentary organic matter. The close resemblances of hydrocarbons in sediments and crude oils to plant and animal products, show that most of these hydrocarbons are obtained either directly from the remains of living things or are minor modifications of living matter. Although many sediment and petroleum hydrocarbons are of the same type and are derived from a common source, the distributions of these compounds in petroleum differ from their distributions in sediments. Therefore, the conversion or accumulation of sedimentary organic matter to form petroleum must be done selectively. An explanation is presented of how water serving as the accumulating agent can produce the changes in distribution that are observed between sedimentary organic matter and petroleum. --Auth.

1-1556. Fox, F. G. STRUCTURE AND ACCUMULATION OF HYDROCARBONS IN SOUTHERN FOOTHILLS, ALBERTA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 992-1025, 2 maps, 9 cross secs., table, May 1959, 26 refs.

The southern foothills of Alberta are composed of much compressed, imbricately faulted Paleozoic and Mesozoic rocks in an elongate belt between the Great Plains and the Rocky Mountains. Within the belt structural shortening evidently has been achieved mainly by thrust faulting, accompanied by the development of drag folds, most of which are not large. The major thrust faults lie in well-defined sliding zones, and they generally transect the bedding at relatively low angles. This is true for supposedly competent as well as incompetent beds, although there is apparently some refraction of fault planes between beds of differing competence. At and near the surface the faults commonly dip steeply, but this is a result of rotation and is not indicative of the dips the faults had when formed.

Structures that originated as folds and were later faulted may not exist. Turner Valley anticline, which is commonly regarded as a faulted fold developed from a protofold, might be an exception, but the evidence is by no means conclusive.

In this area oil and gas have been found in Cretaceous, Mississippian, and Devonian rocks. The reservoirs tapped to date are associated with thrust faults, and it appears that, with the possible but unproved exception of the Turner Valley pool, all the traps are fault traps. Migration of hydrocarbons might have started very early, but was not completed before the close of the Laramide revolution. There is no reason to suppose that all hydrocarbons migrated at once, or in any one direction, or that the process of migration was uninterrupted. --Auth.

1-1557. Rudolph, John C. BELLSHILL LAKE FIELD, ALBERTA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 4, p. 880-89, 4 struct. maps, cross-sec., log, Apr. 1959, 2 refs.

One of the most disappointing strata in Alberta's history of oil exploration has been the Basal Quartz sand of Blairmore (Lower Cretaceous) age. To date, production from this section has been of very minor importance, most of the small fields found being characterized by extreme lenticularity of sand and consequent very poor production histories. The recently discovered Bellshill Lake field, however, is a marked exception to past results in the Basal Quartz. It is a good field and the forerunner of similar accumulations to be found in the future.

The Bellshill Lake field is in T. 41, R. 12, W. 4th Mer., about 140 mi. NE. of Calgary, about 90 mi. SE. of Edmonton, and 11 mi. NE. of the town of Alliance. The discovery well is Richfield McLennan No. 6-32, drilled by Richfield Oil Corporation, which was completed in Sept. 1955, with a gross pay thick-

ness of 37 ft. in the Basal Quartz sand of Lower Cretaceous age. As of Oct. 31, 1958, there were 78 oil wells in the field on 40-acre spacing, and probably additional 12 locations yet to be drilled, giving a probable areal extent of 3,600 acres. The average depth of field wells is about 3,100 ft. To Oct. 31, 1958, the field had produced 1,431,810 barrels of 27°-28° API gravity oil with an average GOR of 259 and 415,237 barrels of water. The field is connected by Gibson Pipeline to the Interprovincial Pipeline at Hardisty, a distance of 16 mi. --Auth. introd.

1-1558. Meents, Wayne F. FREEBURG GAS POOL, ST. CLAIR COUNTY, ILLINOIS: Illinois, State Geol. Survey, Circ. 272, 19 p., 5 figs., 3 tables, 1959.

The Freeburg gas pool, discovered in 1956, is near the western border of southern Illinois and at the W. edge of the main oil and gas producing region. Twenty-nine gas wells in the pool in an area of 2,400 acres had initial open-flow capacities ranging from 139,000 to nearly 4 million cu. ft. per day from Cypress sandstone. Average depth to the top of the gas pay is 335 ft. At present the wells are shut in, but the contract for a pipeline has been let, and gas should be marketed in the East St. Louis area by the winter of 1959.

The Freeburg gas reservoir and its underlying formations may be important for the underground storage of natural gas brought from other areas. Because of the economic importance of the gas reservoir, the geology and production history of the area are summarized here. --Auth.

1-1559. Bates, Fred W., Robert R. Copeland, Jr., and Kenneth P. Dixon. GEOLOGY OF AVERY ISLAND SALT DOME, IBERIA PARISH, LOUISIANA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 944-57, 7 figs. incl. 4 maps, May 1959, 3 refs.

Two important papers on the geology of Avery Island dome (one of the often mentioned "Five Islands" of S. Louisiana) were published in 1899 and 1931. The present study reports the findings since the discovery of oil in 1942. The history of salt-mine operations is reviewed, present mining practices explained briefly, and the configuration of the salt mass as it is now known is described. Oil sands have been found ranging in depth from 4,500 ft. to 15,600 ft.; 16,456 ft. is the greatest depth to date drilled. The bulk of the proved reserves ranges from about 8,500 to 9,500 ft. in depth and is located on the SW. flank. Present drilling is mainly to define new deep reserves on the E. flank, or explore for new reserves on the SE. flank. Accumulative production totals about 34 million barrels of oil with minor volumes of gas as of May 1, 1958. The total proved reserve is probably about half depleted, with good possibilities for new reserves being discovered on untested or deeper flanks.

The structure of the drilled flanks has been found to be a complex of radial faults, salt overhang, and steeply dipping sediments with updip terminations against the shallow piercement-type salt mass. The age of formations penetrated ranges from Recent to the Discorbis zone of the middle Miocene. --Auth.

1-1560. North Dakota Geological Society, Bismarck, North Dakota. NESSON ANTICLINE OF NORTH DAKOTA: 81 p., fold. map, charts, cross secs., logs, Apr. 1959, 9 refs.

The manual includes reservoir data for 29 pools, type log for 27 pools, 2 cross sections across the length and breadth of the anticline, unitization for secondary recovery operations in 2 of the oldest and biggest fields, and charts and an index map which summarize developments and growth in reserves. --North Dakota Geol. Soc.

The manual was prepared by the Nesson Anticline Committee of the North Dakota Geological Society, consisting of: Jack B. Mills, Chairman, William Bolenbaugh, James S. Cantrell, Robert S. George, Gene O. Kennedy, William M. Pendleton, Jack W. Pierce, and K. W. Roth. Nesson Anticline Structure Map, also prepared by this Committee, is listed in this issue of GeoScience Abstracts under Section 1. Geologic Maps.

1-1561. Shearrow, George G., John C. Wright, Brady Johnson, and Graham Robb. CONTRIBUTIONS TO THE OIL AND GAS INDUSTRY IN OHIO: Ohio, Div. Geol. Survey, Inf. Circ. no. 23, 35 p., 6 maps, 8 charts, 4 tables, 1959.

This is a collection of papers presented at the Third Winter Meeting of the Ohio Oil and Gas Association in Columbus, Ohio, Feb. 20, 1959. The titles are: Deep possibilities in Ohio, and Services available at the Ohio Geological Survey, both by George G. Shearrow; Production curves on fractured Clinton oil wells, by John C. Wright; Cutting operating costs, by Brady Johnson; and Repressuring - with gas and water, by Graham Robb. --P. Smyth.

1-1562. Shearrow, George G., and Theodore A. DeBrosse. 1958 OIL AND GAS DEVELOPMENTS IN OHIO: Ohio, Div. Geol. Survey, Rept. Inv. no. 37, 29 p., 3 illus., 14 tables, 1959.

In 1958 in Ohio 6,525,000 barrels of oil and 33,875,000,000 cu. ft. of gas were produced, an increase in both oil and gas over 1957. Of a total of 1,168 wells drilled, 260 were gas, 238 were oil, 354 were combination, and 316 were dry holes. The average depth per well was 2,379 ft. The ratio of successful completions of all wells was 73%. Eight "deep wells" penetrated the lower Ordovician and Cambrian sediments, and 3 of these reached the Precambrian basement rocks in western Ohio.

The report includes a summary of drilling statistics by producing horizon and by county and a list of well sample cuttings and cores received during the year by the Ohio Geological Survey. --P. Smyth.

1-1563. Duck, James H., Jr. THE NORTHWEST BUTNER POOL AREA, SEMINOLE COUNTY, OKLAHOMA: Shale Shaker, v. 9, no. 5, p. 5-21, 8 figs. incl. maps, secs., diag., graph, Jan. 1959, 21 refs.

The following statements were derived from this study of the Northwest Butner pool and the surrounding area.

The Marmaton group [Pennsylvanian] is characterized by intertonguing of the sandstones and shales and contains no persistent limestone beds. Sandstones of the Cabaniss group are highly lenticular, and limestones are subordinate to the shales and sandstones. Sandstones of the Kerbs group vary from lenticular (Red Fork, Bartlesville) to persistent (Booch) in their development, and limestone beds are common. The Atokan series contains the highly erratic Gilcrease sandstones. Pre-Atoka post-McLish formations are primarily relatively pure sandstones, thick shales,

and limestones. Formations of the upper Morrowan, Atokan, and Des Moinesian series thin to the north and west across the area. The Henrietta coal is the youngest reliable bed for subsurface mapping. Other good horizons are the Inola limestone, Union Valley limestone, and Viola limestone.

Several unconformities are recognizable in the subsurface of this area. These are located at the top of (1) the Atokan series, (2) the Morrowan series, (3) the Springeran series, and (4) the Hunton limestone. These unconformities do not completely truncate any of the underlying formations within the area. Additional unconformities are difficult to recognize because of the relatively small study area and questionable correlations. Pre-Atoka structural features are reflected in post-Atoka beds, but appear as anticlinal "noses" or with less closure.

Production from this area is found in structural and stratigraphic traps. Stratigraphic accumulations seem to be frequently associated with deeper anticlinal "highs" or "noses". The structure of the Northwest Butner pool is a dome located in a graben. Recovery of oil from the Senora sandstone reservoir of this pool should be increased over 175% by the water injection program. Unitization of the pool was necessary for this project. The Senora sandstone offers several prospects for future oil discoveries, but accumulations, if present, will be small. Future prospects of the Booch sandstone appear good in view of several shows in undeveloped areas. Based on available data, pre-Atoka sediments offer little chance for production, but review of geophysical data may locate small domes or faulted anticlines. The lack of commercial production from the well-developed structural and stratigraphic traps of the Red Fork sandstone substantiates the theories of Weirich. --Auth concl.

1-1564. Read, John L., Jr. GEOLOGIC CASE HISTORY OF SLOCUM DOME, ANDERSON COUNTY, TEXAS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 958-73, 13 figs. incl. 10 maps, May 1959, 6 refs.

The Slocum dome is a deep-seated interior salt dome in NE. Texas. It furnishes a recent example of a "condemned prospect" rediscovered. Dense well control and reliable stratigraphic correlation allow a subsurface geologic case history that tells a story continuously repeated in the older oil-producing provinces.

Oil production was established in the Slocum area in 1935 from Woodbine and sub-Clarksville sands of Upper Cretaceous age. The initial production was located on the NW. flank of the dome and was depleted by 1938. Significant production from the same formations on the SE. flank was discovered in 1956, and active development has resulted in 15 new reservoirs. Ninety percent of the cumulative production of nearly 2 million barrels through 1957 is credited to the new reservoirs.

The dome is characterized by an elliptical outline and a central graben located transverse to the elongate axis. Radial faulting and stratigraphic variation combine to form several different types of oil and gas traps on the flanks of the dome. Cross sections and isopachous maps reveal sand truncation during structural growth and the changing effect of domal growth on the area of its influence.

The geologic history of this dome has economic applications in NE. Texas and in areas of similar geology. Evidence furnished concerning the area condemned by a single dry hole probably applies in every oil province. --Auth.

1-1565. Ireland, H. Andrew. OIL DEVELOPMENT IN THE MIDDLE EAST: Compass, v. 36, no. 4, p. 264-71, map, May 1959, refs.

Western Europe is almost entirely dependent, and the United States is increasingly dependent, on Middle East oil. Several geologic factors have resulted in unusually favorable conditions for oil accumulation in the Middle East, and it is here that prospects are best for a continuing supply of oil. American foreign policy must be directed toward protecting this supply and the best way is to understand and heed Arab politics. --M. Russell.

1-1566. Melik-Pashayev, V. S. SOME QUESTIONS RELATED TO THE FORMATION OF OIL STRUCTURES IN APSHERON. Translated by Salih Faizi: Internat. Geology Rev., v. 1, no. 3, p. 17-30, 7 figs., March 1959, 28 refs.

The oil and gas deposits of the Apsheron peninsula, U. S. S. R., are controlled by structures which include oil- and gas-bearing beds in the crests of folds and tectonically terminated deposits and by lithology. Oil deposits located symmetrically at the crests of anticlines are related to the secondary origin of oil-bearing beds in the upper parts of productive sequences. In some cases, the formation of oil deposits is related to buried mud volcanos, to which a tectonically terminated trap may be confined.

The determination of submarine structures, gentle folds plunging due S., and lines of possible vertical migration is very important for the selection of suitable locations for petroleum exploration. Prospecting for tectonically terminated traps requires a detailed tectonic study of the lower part of the productive sequence and of the directions of lateral oil migration. The lithologically controlled traps related to the pinching out of oil-bearing groups having great lateral extension along the strike and small width require well-spaced drill holes along the strike.

In the course of prospecting for oil on the Apsheron peninsula, it was found that the majority of exploration drill holes recovered cores containing oil in deep depressions far from the crests of anticlines; some oil pools were confined to areas of exceptionally favorable lithology deep in plunging flanks, one in a syncline, and others in unfolded areas. This indicates the importance of lateral and, in some cases, vertical migration in the formation of oil deposits. --G. E. Denegar.

1-1567. Cady, Gilbert H. ANTHRACOLOGIC ANALYSIS, A GUIDE TO THE APPLIED PETROLOGY OF OHIO COALS: Ohio, Div. Geol. Survey, Inf. Circ. no. 22, 83 p., illus., 1958, 151 refs.

Anthracologic analysis of coal involves the description of the physically distinguishable components which are present in coal. In American anthracologic analysis the procedure is to describe the coal accurately, studied in terms of its original botanic components. The European method is to examine and describe coal as a rocklike petrologic substance which, irrespective of its original botanical composition, consists of 4 types of coal material.

Two types of analyses are made. The profile analysis provides a reproduction of the textural pattern of the coal bed in a symbolic manner, either by even steps or by uneven units represented by natural benches of the coal beds. The broken coal analysis is applied to broken coals produced by mining and preparation processes or by deliberate

crushing of column samples.

Information concerning the petrographic or microscopic composition of coal has geological significance in 2 ways. One has to do with the origin of coal and the character and effect of carbonification, as revealed by the nature and physical characteristics of the constituents, components, lithotypes, microlithotypes, and macerels. The second way is in connection with the problems of stratigraphy and correlation.

The general purpose of this report is to describe and evaluate various procedures and techniques available for use in the petrographic description and analysis of Ohio coal beds. The report further serves as a general introduction to the subject of coal petrographic analysis and illustrates the general nature of the science. --P. Smyth.

1-1568. Pierron, E. D., O. W. Rees, and G. L. Clark. PLASTIC PROPERTIES OF COAL: Illinois, State Geol. Survey, Circ. 269, 36 p., 7 figs., 4 pls., 16 tables, 1959, 48 refs.

Two coals of similar chemical analyses and plastic temperature characteristics but of different maximum fluidities (Gieseler) were investigated to determine what components of coal are responsible for its plastic properties. An Illinois high-volatile B bituminous coal and an eastern high-volatile A bituminous coal were investigated. A portion of the Illinois coal that had been oxidized in air until its plastic properties were destroyed also was studied.

The 3 samples were subjected to an extraction procedure. The coals were extracted with pyridine, the pyridine extract was then extracted with chloroform, and finally the chloroform extract was extracted with n-hexane. The coals and their extracts and residues were analyzed and the atomic H/C and O/C ratios were calculated. They were investigated further by X-ray scattering and infrared spectroscopy. Their plastic characteristics were determined by the Gieseler plastometer and the hot-stage microscope, and the relative thermal decomposition ranges were ascertained by differential thermal analysis. Molecular weight determinations were made on all materials except the original coals and the residues from the pyridine extractions.

Pyridine extraction of the coals rendered the residues nonplastic. The yield of extract for each solvent appears to be proportional to the fluidity. Chemical, X-ray, and infrared data showed a relative increase in aliphaticity with each progressive extraction. In each series, as the progressive scheme of extraction is carried out, each extract possesses a lower melting point, a lower molecular weight, and a similar thermal decomposition temperature range. In each series, the pyridine, chloroform, and n-hexane extracts are similar to the corresponding extracts of the other coals studied. --Auth.

1-1569. Hutchison, Harold C. DISTRIBUTION, STRUCTURE, AND MINED AREAS OF COALS IN SPENCER COUNTY, INDIANA: Indiana, Geol. Survey, Prelim. Coal Map 8, scale approx. 1 in. to 2 mi., 1959.

Geologic cross sections showing the commercial coal beds and a generalized columnar section showing the type of rocks that lie between the coals are included. Listed in tables are the names and other pertinent information concerning many of the more important mines, tons of coal produced annually from 1900 through 1957, and the coal reserves of Spencer County as of Jan. 1958. It is calculated that as of that date more than 67,000,000 tons of high-volatile bituminous coal is available by present mining methods. The coals in Spencer County vary greatly in thickness. Reserves were calculated only for the areas where each coal is known to be of mineable thickness. --Auth.

14. ENGINEERING GEOLOGY

See also: Geohydrology 1-1525.

1-1570. Trask, Parker D. EFFECT OF GRAIN SIZE ON STRENGTH OF MIXTURES OF CLAY, SAND, AND WATER: Geol. Soc. America, Bull., v. 70, no. 5, p. 569-79, 9 figs., 2 tables, May 1959, 13 refs.

Many factors affect the strength of what engineers call soil. This report deals primarily with the effect of the grain size of sand or silt particles mixed with the clay in the soil. In order to understand the effect of grain size, the influence of (1) water content, (2) type of clay mineral, and (3) ratio of clay to sand in the soil must be known. The effect of these 4 variables was investigated by measuring the strength of a series of synthetic soils in which the water content, clay type, clay-sand ratio, and grain size of admixed sand were changed from one experiment to another. For given water content, kaolin and illite are essentially equal in strength, and both are much weaker than montmorillonite. Ball clay - a kaolin containing organic matter - is intermediate in strength. For all clays the strength increases, for given water content and given grain size, as the ratio of clay to sand increases. For given water content and given clay-sand ratio, the strength increases as the grain size of the sand decreases below 135 microns. For coarser sand, grain size has little effect. The cause of the greater strength for increasing fineness of sand is ascribed to the well-known principle of greater surface area upon which forces can act. --Auth.

1-1571. Judd, William R. EFFECT OF THE ELASTIC PROPERTIES OF ROCKS ON CIVIL ENGINEERING DESIGN: (In: Trask, Parker D., ed. Symposium on Rock Mechanics, presented before the Division of Engineering Geology, The Geological Society of America, St. Louis, Missouri, Nov. 6, 1958) Eng. Geology Case Histories, no. 3, p. 53-76, 14 figs. incl. diags., graphs, 4 illus. on pl., May 1959, 35 refs.

In recent years the engineering geologist has entered a picture formerly occupied primarily by mining engineers concerned with the nature of rock bursts in mine tunnels. Now, the civil engineer can achieve better and more economical designs by utilizing the engineering geologist to weave together the tectonic history of a site with the test results and the future effect of forces to be imposed by the man-made structure. Knowledge of the unconfined compressive strength of rock no longer is considered adequate. Reliable data on the modulus of elasticity and Poisson's ratio of the rocks that will underlie the structure permit the civil engineer to

take advantage of the inherent elastic properties of the rocks. Reductions can be achieved in the amount of steel in tunnel linings, concrete in arch dams, support in underground chambers, and yardage to be excavated in conjunction with these structures. For example, tests prior to the final design of the Cubatão Underground Powerplant (Brazil) tunnels resulted in the elimination of almost 80% of the lining steel; it was found that a considerable part of the internal hydrostatic pressure could be transmitted to the rock surrounding the lining.

Despite the wealth of available data on rock properties, much is conflicting, uninterpreted, or inapplicable to civil-engineering problems. A major research problem is how to correlate field tests in situ with laboratory tests on rock specimens. A corollary is: "Which test method most nearly provides the actual in situ properties of a rock formation?"--Auth.

1-1572. Moody, W. T. IMPORTANCE OF GEOLOGICAL INFORMATION AS A FACTOR IN TUNNEL-LINING DESIGN: (In: Trask, Parker D., ed. Symposium on Rock Mechanics, presented before the Division of Engineering Geology, The Geological Society of America, St. Louis, Missouri, Nov. 6, 1958) Eng. Geology Case Histories, no. 3, p. 45-51, 2 figs., May 1959, 8 refs.

The writer outlines the progressive requirements of the engineer for geologic information as a project develops and defines the need for certain quantitative information in final design stages. Methods of obtaining and evaluating such information are discussed. Equations are given which illustrate the role that the modulus of elasticity of the rock plays in proportioning the elements of a pressure-tunnel lining. This effect is portrayed graphically by a dimensionless chart and is exemplified by computations showing the specific effect upon steel-lining thickness. In conclusion, the importance of developing more reliable and simpler methods of determining the elastic properties of rock is stressed. --Auth.

1-1573. Puig de la Parra, Juan B. FOTOGEOLOGIA APLICADA A LA INGENIERIA DE CARRETERAS [PHOTOGEOLOGY APPLIED TO HIGHWAY ENGINEERING]: Soc. Geol. Mexicana, Bol., v. 21, no. 1, p. 5-27, 1958.

The author recommends greater use of photogeology in the construction of land communications and points out that benefits result both in engineering and in geological knowledge. In the engineering field the products are a geographic map, the general lay-out of the route, secondary roads, localization of bridges, a preliminary study for tunnels, methods to be used for construction, photogrammetry, and the size of the areas affected. In geology the benefits gained are a knowledge of the regional geology, lithology, stratigraphy, tectonics, geomorphology, water supply, availability of construction materials, and special problems, such as faults, landslides, etc.

The author then briefly describes the steps taken to plot a projected road with the help of aerial photographs. --R. van Vloten.

1-1574. Moye, D. G. ROCK MECHANICS IN THE INVESTIGATION AND CONSTRUCTION OF T.1 UNDERGROUND POWER STATION, SNOWY MOUNTAINS, AUSTRALIA: (In: Trask, Parker D., ed. Symposium on Rock Mechanics, presented before the Division of Engineering Geology, The Geological Society of America, St. Louis, Missouri, Nov. 6, 1958) Eng. Geology Case Histories, no. 3, p. 13-44, 12 figs. incl. maps, plans, diags., graphs, 16 illus. on 7 pls., May 1959, 14 refs.

T.1 Power Station is 1100 ft. underground under the eastern wall of Tumut River gorge in the Snowy Mountains of southeastern Australia. The machine hall is 306 ft. long, 77 ft. in maximum width, and 104 ft. in maximum height.

In selecting the site major faults in the region were avoided. The rock is granite in steeply inclined sheets up to 300 ft. thick intrusive into granitic gneiss. Both rocks have compressive strength of approximately 20,000 p. s. i., tensile strength 1100 p. s. i., and Young's Modulus 7-10 x 10^6 p. s. i. Jointing in both rocks follows a similar pattern but is much more closely spaced in the gneiss.

Original natural stresses in the rock mass, which are an important factor in the behavior of openings, were computed from measurements of stress in the excavations. These are higher, particularly in the horizontal plane, than can be accounted for by the weight of overlying rock alone.

The openings were located mainly in the granite and oriented to avoid main joint directions parallel to the walls. Photoelastic studies were made to determine the stress concentrations caused by the shape of the openings and by different arrangements of multiple openings.

Comprehensive investigations were made to study how rock bolts function in hard jointed rock, and during excavation, pattern of rock bolts was used to stabilize the jointed rock in the roof and walls. The excavations were made without major rock falls. Some instrumental observations of the behavior of the walls and roof of the machine hall were made during construction. --Auth.

1-1575. Jordan, Louise. PROPANE STORAGE IN SHALE, SEMINOLE COUNTY, OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 5, p. 102-105, 2 figs., May 1959, refs.

An underground cavern of 110,000-barrel capacity for storage of propane was constructed in 1955 by a modified room-and-pillar mining method for Sinclair Oil & Gas Company in Seminole County, Oklahoma. Nellie Bly shale, underlying the Belle City limestone, was mined to a depth of 276 to 345 ft. below the surface. The limestone, averaging 11 to 13 ft. thick, serves as roof of the cavern. Height of tunnels ranges from 15 to 28 ft.; average width of tunnels is 8 ft. Two shafts now lined with 42-in. and 14-in. cemented casings respectively contain 8 5/8-in diameter pipe strings with foot valves at the bottom. Pump pressure of 200 pounds per square inch at the gasoline plant's storage tanks transfers the propane from the tanks into the underground cavity, and two 4- and 7-inch deep well type centrifugal pumps remove it for shipment. Liquefied propane under 150 pounds-per-square-inch pressure is stored in summer and withdrawn in winter to meet market demand

The rock section from the surface to the base of the cavern consists of the following formations: Vamoosa (Virgilian, Pennsylvanian), and Hilltop, Belle City, and Nellie Bly (Missourian, Pennsylvanian), and is illustrated by columnar sections and electric log. --Auth.

1-1576. Hogg, A. D. SOME ENGINEERING STUDIES OF ROCK MOVEMENT IN THE NIAGARA

AREA: (In: Trask, Parker D., ed. Symposium on Rock Mechanics, presented before the Division of Engineering Geology, The Geological Society of America, St. Louis, Missouri, Nov. 6, 1958) Eng. Geology Case Histories, no. 3, p. 1-12, 13 figs., 2 tables, May 1959.

Two parallel, essentially horizontal, 50-ft.-diameter tunnels spaced 250 ft. apart were excavated in the horizontally stratified rock of the Niagara area, about 200 ft. below the rock surface and 300 ft. below the surface of the ground. Surface rock cuts up to 60 ft. deep were also made for canals and intake structures. Measurements for a few months after excavation showed a decrease in the horizontal diameter of the first tunnel of 1-2 in. Corresponding figures for the second tunnel excavated some months later were about one-third of this. Some crushing of the sandstone occurred below the tunnel. Inward movements of canal walls have been about 1 in. All rock movements approximate straight lines when plotted against the logarithm of time; thus much the greater part of the total probable unrestrained movement for, say, 100 years took place before any concrete structures were placed.

Owing to the cooling contraction of the tunnel-lining concrete, no rock-movement load has come on the lining. A stress of some 300 p. s. i. occurred in a slab at the bottom of a surface rock cut when an adjacent rock plug was removed from the cut.

Steel ribs supporting the tunnel roof during construction showed stresses from zero to 60% of their design load.

The various structures associated with these excavations appear, as designed, to be fully capable of withstanding any rock movements likely to occur. --Auth.

1-1577. MacDonald, Gordon A. BARRIERS TO PROTECT HILO FROM LAVA FLOWS: Pacific Science, v. 12, no. 3, p. 258-77, 9 figs. incl. illus., maps, diags., graphs, July 1958, 21 refs.; also pub. as: Hawaii, Univ., Inst. Geophysics, Contr. no. 6.

Author believes (1) that lava flows are certain to enter the city and harbor of Hilo [Hawaii] eventually unless something is done to prevent their entry; (2) that they can be successfully diverted from the city and harbor by properly located and constructed barriers; (3) that no other method can be relied upon to divert the flows; (4) that construction of the barriers in advance of the eruption is preferable, but that barriers probably can be constructed in time even after the flow has started to advance toward Hilo; (5) that the barriers need consist only of loose rubble obtained locally and pushed into place by bulldozers; and (6) that the barrier alignment proposed by the U. S. Engineer Department in 1940 is adequate to protect the center of the city and the harbor, but an alignment farther SW. is necessary if it is desired to protect all of the city. --Auth. concl.

1-1578. U. S. Army, Corps of Engineers, Engineer District, New Orleans, La. MISSISSIPPI RIVER, BATON ROUGE TO GULF OF MEXICO; INVESTIGATIONS AND DATA COLLECTION FOR MODEL STUDY OF SOUTHWEST PASS, MISSISSIPPI RIVER; PROTOTYPE INVESTIGATION: 2 v.: v. 1, text, 8 figs. incl. illus., 2 fold. maps, graph, 18 tables; v. 2, plates (23 maps, charts, graphs), Apr. 1959, approx. 100 refs.

This report, in 2 volumes, presents pertinent data selected from previous data collection programs and special investigations, and all of the data collected during the comprehensive data collection program in the Southwest Pass of the Mississippi River and vicinity from Oct. 1956 through Nov. 1957. The field data were collected in 1956-57 primarily for use in verifying the model of Southwest Pass and Bar Channel that was constructed by the U. S. Army Engineer, Waterways Experiment Station, Vicksburg, Mississippi, to study the shoaling problems in the 35-ft. project channel and to develop plans to obtain and maintain a 40-ft. navigation project. The field data are also being used in a rational analysis of the problem.

Continuous observations were made of velocity and direction of flow at selected stations in the pass channel and in the open gulf; wind velocity and direction at Burrwood, Louisiana; wave height, direction, and period in the gulf; and water-surface elevations at several locations in the pass and in the gulf. During a 25-hour period, comprehensive and continuous hourly observations of velocities and directions of flow, and measurements of concentration of salt were made at various sites in the pass and in the gulf at approximately every 4-ft. increment of rising and falling stage of the Mississippi River at the Carrollton gage (New Orleans, La.) concurrent with a spring tide and a neap tide in the Gulf of Mexico. Semimonthly surveys of bed topography and shoaling in the pass channel were made. Hydrographic surveys and maps of the outer bar and vicinity were made for use in the construction and verification of the model. Datum was established and maintained during the data collection program by precise levels. Supplementary observations were made for various purposes during the progress of the program.

Previous data collection programs and special investigations of the study area were reviewed and pertinent data included in this report. The map history of Southwest Pass, a record of all construction performed to obtain and maintain a 35-ft. channel, and a chronology of references to information, including letters, reports, and publications, are included.

Volume I contains a general description of the problem, authorization for the project, an outline of instrumentation, and operational features of the data collection program, a list of pertinent references, and parts of the field data.

Volume II contains plates of historical maps showing topographical changes in the problem area, summaries of previous investigation, records of construction, typical shoal formations, drawings of the instrumentation, surveys during the period of observations and plots of certain special measurements. An index of both is included in each volume. The report records the field data collected during 1956-57 and lists textual and cartographic source material. No attempt is made to present a solution to the problem--Auth. summ.

1-1579. Bain, George W. PRINCIPLES OF GEOLOGY: 563 p., 12 figs., 40 pls., 276 drawings, Amherst, Mass., Amherst College, Dept. of Geology, 1959.

This textbook of physical geology was prepared specifically for the more mature and serious student. The dramatic episodes are muted to accent the major geologic influences on development of earth features.

The arrangement considers first the gradational processes, and proceeds to treat consolidation, restoration, and geology in human affairs in that sequence; each part receives nearly equal space and equal intensity of treatment. The sequence of presentation of the activity by gradational agents is in order of decreasing fundamental influence; activity of the restorative agents is described in order of increasing attainment in restoration of land area. Slow gradation to plain and rapid restoration to highlands is the underlying theme.

Presentation of topics is more exacting, specific, and quantitative than in the existing textbooks. Inductive study of cases supplants deductive generalizations in most instances, and this evolves some new points of view particularly concerning the restorative agents. Every illustration represents an actual place thereby introducing some regional geology as a phase to development of principles.

Although the textbook was prepared for use by the more inquisitive student, the introductory paragraphs to each chapter adapt it to a survey course, and the footnotes make it useful to the graduate student. References do not include other textbooks but list scholarly investigations of special features of sufficient import to merit the attention of those desiring greater insight into varied aspects of geology. --Auth.

1-1580. Baird, David M. AN INTRODUCTION TO GEOLOGY: 111 p., Toronto, Canadian Broadcasting Corporation, 1959, 10 refs.

This book contains the texts of 8 half-hour talks as broadcast on the "University of the Air" series of the Canadian Broadcasting Corporation in 1958. The talks were designed to interest people of no technical training in the geological sciences. The first lecture shows that beauty and observation of the natural world can be mutually reinforcing, that geology is a part of all knowledge because it overlaps on so many other areas of interest. A short examination of what the scientific method is and how it is used by geologists is followed by a look at mass wasting and what causes movement of large pieces of ground; how wind produces characteristic landscapes and what happens to dust and sand moved by the wind; a survey of rivers and streams; the oceans and their shores. Glaciers and their movements down mountain valleys or their massive thrusting across the continental faces are described, and it is shown how powerfully they have affected Canada and the northern United States.

Attention is then turned to the enormous span of time since earth began and how it is measured. A brief excursion into the interior construction of the earth shows what little we know about the hidden regions but how very far we have advanced from total ignorance. The last lecture deals with the search for useful things among mineral substances or economic geology, with some enquiry into methods used to find out how minerals get there and how that knowledge can be used to man's benefit. --Auth.

1-1581. Howell, J. V. THE PRESENT STATE OF GEOLOGICAL TERMINOLOGY: Jour. Geol. Education, v. 7, no. 1, p. 18-21, Spring 1959.

Preparation of the AGI Glossary of Geology and Related Sciences has provided an opportunity for study of the state of our means of communication among ourselves and to the public. This note attempts to call attention to some glaring weaknesses and to point out means of avoiding future offenses.

Criticisms are made of the following procedures: (1) introduction of new terms to replace old and well-understood words, (2) redefinition of old established terms, (3) proliferation of new terms for features or concepts readily defined in simple non-technical words, (4) use of terms so vague that definitions must always accompany their appearance, (5) coining of terms containing both Greek and Latin combining forms.

Geology has been afflicted with these evils for many years, but great expansion in numbers of geologists and publications of recent years has served to aggravate the condition. While the use of the glossary should prevent further use of old terms for new things, only careful study of the pertinent literature will enable an author to avoid the sin of applying new names to old things. At least until the material of the glossary has been organized into thesaurus form, the burden rests solely on the author himself. --Auth.

1-1582. Weller, J. Marvin. TECHNICAL VAGARIES OF GEOLOGIC LANGUAGE: Jour. Geol. Education, v. 7, no. 1, p. 22-24, Spring 1959.

Teachers should be concerned with (1) unnecessary technicalities in geologic language, (2) substitution of new technicalities for old ones, and (3) multiple meanings of technical expressions. Teachers can perform an important service by pointing out these faults to students. Editors should be more critical of technical vocabularies. --Auth.

1-1583. Brown, Bahngrell. PRELIMINARY STUDY OF STOCHASTIC TERMS USED IN GEOLOGY: Geol. Soc. America, Bull., v. 70, no. 5, p. 651-53, table, May 1959, 7 refs.

A more precise meaning of terms denoting probability or likelihood as used in geology is needed. If the limits of probability p are considered to be 1 for most probable and 0 for least probable then the following terms and equivalent degree of probability are suggested: impossibly, limit of p approaches 0; improbably, p is less than .5; equally likely, p approximates .5; probably, p is greater than .5; undoubtedly, limit of p approaches 1; possibly, indeterminate probability ranging from 1 to 0. --M. Russell.

1-1584. Niemala, Lauri J. A GLOSSARY OF FINNISH MAP TERMS: Prof. Geographer, v. 11, no. 3, p. 10-16, May 1959, 2 refs.

In spite of the language difficulty, it is possible for scholars to use the excellent Finnish maps which are readily available, once the legends or captions have been translated. This glossary was compiled from the newest series of Finland's large-scale maps - economic, topographic, and parish - and from maps of common geographic distributions appearing in Finnish periodical literature and atlases. Some 400 map terms are given with their English equivalents. --A. C. Sangree.

1-1585. Chronic, John, Halka Chronic, and Petroleum Research Corporation, Denver, Colorado. BIBLIOGRAPHY OF THESES WRITTEN FOR ADVANCED DEGREES IN GEOLOGY AND RELATED SCIENCES AT UNIVERSITIES AND COLLEGES IN THE UNITED STATES AND CANADA THROUGH 1957: [426] p., Boulder, Colo., Pruett Press, Inc., 1958.

The bibliography lists alphabetically by author 11,091 theses in geology, geophysics, geochemistry, geological engineering, and petroleum engineering. Mining theses are given if their titles indicate that any aspect of geology is discussed. Some theses in meteorology have been included if they have geological or geophysical implications. Bachelors' and other undergraduate theses or papers are not listed.

In addition to the author's name, information given includes title of thesis, date, degree (M. S., Ph.D., etc.) and university or college for which thesis was written. An index of geologic formation and group names and a general (regional and subject) index are included. --A. C. Sangree.

1-1586. Mills, B. A., comp. BIBLIOGRAPHY OF GEOLOGY, PALAEONTOLOGY, INDUSTRIAL MINERALS, AND FUELS IN THE POST-CAMBRIAN REGIONS OF MANITOBA, 1950-1957: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 57-4, 32 p., 1959.

This bibliography, compiled to serve as an index to geological articles dealing with that part of Manitoba underlain by rocks of post-Cambrian age, covers the period 1951 to 1957 inclusive and is supplementary to Mines Branch Publication 51-2, Bibliography of Geology, Palaeontology, Industrial Minerals, and Fuels in the post-Cambrian Regions of Manitoba to 1950. A few articles published before 1951 but omitted from Publication 51-2 are included in the present bibliography.

The bibliography has been divided into 3 parts. In Pt. I references are indexed according to authors in alphabetical order ... The complete title of the article, the publication in which the article appears, the page number, and date are included for each reference.

Part II lists the reference according to subject matter; only the author's name and title of the article is given. For the complete reference, Part I should be consulted.

Appendix I of Part III contains a short list of stratigraphic maps compiled by the Mines Branch. These stratigraphic maps are compilations from available well records and consequently are revised from time to time as additional information becomes available. Several references dealing with drilling activity, oil production figures, and other subjects which cannot be included conveniently in Parts I or II, but which may be of interest to the user of the bibliography are listed in Appendix II. Appendix III lists the authors of articles appearing before 1950 but missing from Publication 51-2. References to such articles are contained also in Parts I and II of the present bibliography. --Auth. pref.

1-1587. Hunt, Charles B. DATING OF MINING CAMPS WITH TIN CANS AND BOTTLES: GeoTimes, v. 3, no. 8, p. 8-10, 34, 4 figs., May-June 1959, 29 refs.

Four general periods in time can be recognized from an examination of cans, bottles, nails, etc., lying about abandoned mining camps: 1) pre-1900 - soldered tin cans, bottles made for stoppering with corks, and square nails; 2) 1900-1920 - soldered tin cans, bottles made for metal caps, and round nails; 3) 1920-1940 - crimped tin cans, machined bottles, auto parts; 4) 1940-present - beer cans, aluminum utensils. Purple discoloration of glass implies activity before World War I. --M. Russell.

1-1588. Buckmeier, F. J. PREPARATION OF GEOLOGIC MANUSCRIPT MAPS FOR REPRODUCTION IN SEVERAL COLORS: South Dakota Acad. Sci., Proc., v. 37, p. 155-57, fig., 1959.

The drafting procedure used by the South Dakota Geological Survey for the production of geologic maps having several colors, is described. Color representation of different geologic rocks to be shown on a geologic map require a separately drafted overlay sheet using black ink. The printer then aligns each overlay so that each desired color registers perfectly in position onto the final lithographically reproduced map. Geologic maps of the Survey are published in 5 or more colors. Leroy drafting equipment is used for speed and accuracy. --D. Lum.

1-1589. Threet, Richard L. ADVANTAGES OF LARGE CONSTANT "ROD CORRECTON" IN STADIA SURVEYING: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 5, p. 1075-1079, fig., May 1959.

Some useful modifications of stadia surveying technique have not generally been adequately explained in textbooks. The advantages of using a constant rod correction over a limited selected rod correction (vertical angle method) or random rod correction (Beaman arc) include simpler computations and faster rod time. Procedures in applying the method are described. --M. Russell.

1-1590. Stone, Kirk H. WORLD AIR PHOTO COVERAGE: Prof. Geographer, v. 11, no. 3, p. 2-6, map, May 1959, refs.

By Dec. 1957 more than half the earth land surface was known to have been photographed from the air at least once. This report very briefly summarizes coverage for each continent. Interest is limited to single and multiple lens air photos which are available, at least to citizens of the country photographed, on permanent or temporary bases. --A. C. Sangree.

1-1591. Moss, John H. REVIVAL OF GEOLOGY IN PENNSYLVANIA HIGH SCHOOLS: GeoTimes, v. 3, no. 8, p. 18-19, May-June 1959.

The Pennsylvania Dept. of Public Instruction has instituted intensified courses in geology, meteorology, and astronomy at the high school level. The problems, procedure used, goals, and benefits described should assist other communities considering like action. --M. Russell.

1-1592. Wilson, James A. GEOLOGY AND THE STUDENT: Compass, v. 36, no. 4, p. 277-78, May 1959.

Undergraduate students of geology should obtain as broad and diverse background as possible; spe-

cialization should come with graduate work. To be successful in geology it is necessary to employ interested initiative in keeping up with the science and this interest should be manifest in the student. --M. Russell.

1-1593. Hagner, Arthur F., and Donald M. Henderson. PROBLEMS IN GEOLOGIC EDUCATION: THE ELEMENTARY COURSE: Jour. Geol. Education, v. 7, no. 1, p. 36-39, Spring 1959.

In Aug. 1958 the Geology Department of the University of Illinois completed its second Summer Institute sponsored by the National Science Foundation. Since further institutes are not planned by the authors, we take this opportunity to sum up the interactions of 82 participants, visiting lecturers, and staff members to problems of geologic education.

Many problems stem from the fact that geology is both a derivative and a natural science in its own right. To handle it requires the ability to think in terms of several variables at once, to recognize problems and ways of dealing with them, and to appreciate the development and significance of hypotheses and the evidence upon which each rests. This calls for the use of judgment. To contribute to the advancement of geologic knowledge requires, in addition, creative ability.

The nature of our science poses problems of student and teacher preparation. Problems imposed by society and our educational system have to do with enrollment and the diverse educational aims of the various colleges and universities.

It was agreed that teachers should stimulate and guide the student in his own development, help him think and write critically and creatively, recognize problems and approaches to them, and appreciate the importance of facts and reasoning from facts. This can be accomplished by conceptual rather than merely informational instruction, by class discussions and reports, and by early research by capable students. The need to attract more of the better science students and for a strong foundation in fundamental sciences was recognized. --Auth.

1-1594. GEOLOGY-GEOPHYSICS STUDENTS IN UNITED STATES AND CANADA IN 1959: GeoTimes, v. 3, no. 8, p. 16-17, 32, 2 graphs, 2 tables, May-June 1959.

A total of 238 U. S. and Canadian colleges report 11,085 students majoring in geology-geophysics. About 70% of the students are undergraduates, 20% are in the M. A. program and 10% in the Ph. D. program. Trends, breakdown of students by semester, country, and subject major reflect recent economic pressures. --M. Russell.

1-1595. Van Sant, Jan F., and William L. Fisher. THE GEOLOGY DEPARTMENT OF THE UNIVERSITY OF KANSAS: Compass, v. 36, no. 4, p. 253-56, 2 illus., May 1959.

More than 60 courses, given by 12 full-time and 5 part-time staff members, are offered to a student body majoring in geology numbering 120 undergraduates and 75 graduates. Prominent members of the staff, significant courses offered, assistantships, equipment, and other facilities are listed. --M. Russell.

1-1596. Agnew, Allen F. STUDENT REPORT WRITING MUST BE IMPROVED: Jour. Geol. Education, v. 7, no. 1, p. 29-32, Spring 1959.

Upon graduation, most of our college students are inadequately prepared to communicate their geologic findings either by writing or by speaking.

Important facets of the problem are: (1) inadequate basic preparation in grammar and composition and (2) insufficient instruction in methods of writing scientific reports.

The first is a problem for the secondary schools rather than the colleges, and should be pushed back into their laps. The second is very much the problem of the college department of geology. --Auth.

1-1597. Hough, J. L. THE WRITTEN WORD: Jour. Geol. Education, v. 7, no. 1, p. 33-35, Spring 1959.

While there is need for improvement in the training given in many elementary and high schools, the college teacher should accept responsibility for developing abilities in communication in the students who appear in his classes. This probably can best be done in connection with the writing of term papers and of field trip and field course reports. A special course in communication is recommended, even at the expense of limiting subject-matter coverage in the curriculum. Graduate students should be given teaching experience to improve their skills in organizing and presenting material and to develop self-confidence.

In writing for publication, a manuscript should be prepared which conforms to the style of the journal to which it is submitted. The preparation of a complete manuscript is a part of the author's task of communication. --Auth.

1-1598. Hunt, Charles B. ABOUT WRITING REPORTS, SOME TIPS FROM G. K. GILBERT: Jour. Geol. Education, v. 7, no. 1, p. 1-3, Spring 1959.

Present day geologists may profit by following some of the practices of G. K. Gilbert in report writing. More complete preparation of maps while in the field, the writing of a first draft of descriptions and interpretations while still in the field, and the writing of a complete caption for each photograph at the time the picture is taken can make the task of final report writing less onerous. --Auth.

1-1599. Whitmore, Frank C., Jr. GEOLOGIC WRITING FOR THE NONGEOLOGIST: Jour. Geol. Education, v. 7, no. 1, p. 25-28, Spring 1959.

One of the problems of communication in geology is that of gauging the capacity of the reader. This is difficult enough when we write for other geologists; it is more difficult when we write for the layman or the specialist in another field such as engineering. Audience capacity, plus the use for which the report is intended, will determine the format and terminology to be employed. An engineering-geology report, for instance, may be designed to be read in its entirety or to be used for reference.

In geologic reports, the map is as important as the text. In a report for nongeologists, modification is often restricted to the text, leaving the map in the standard geologic format. Design of reports for special purposes need not stop here. In studies for military engineers it has proved feasible to prepare special-purpose maps showing such things as the suitability of soil and rock for foundations. Much of

the analysis involved in preparation of such reports is not presented to the reader because he is not qualified to evaluate it. --Auth.

1-1600. Norton, Matthew F., and Ross F. Giese, Jr. AN ECONOMICAL COMPASS AND CLINOMETER FOR BASIC GEOLOGY COURSES: Jour. Geol. Education, v. 7, no. 1, p. 10-12, Spring 1959, 2 refs.

The writers believe that actual practice in basic field mapping enables students to gain a better understanding of abstract spatial relations necessary for intelligent interpretation of topographic maps. They therefore introduce this practice in the laboratory of their first year course.

Since it would not be feasible to equip each member of such a class with a standard compass and clinometer, a simple, inexpensive instrument was designed that has proved satisfactory in use. This paper gives specifications and directions for its construction. --Auth.

1-1601. Bidgood, D. E. T., and W. B. Harland. ROCK COMPASS: A NEW AID FOR COLLECTING ORIENTED SPECIMENS: Geol. Soc. America, Bull., v. 70, no. 5, p. 641-44, 2 figs., May 1959, ref.

The rock compass was developed from the Astrocompass as a piece of field equipment to simplify and quicken the recording of the orientation of rocks being collected for petrofabrics or paleomagnetics studies, and the recovery of that orientation in the laboratory. It is essentially a 3-axis universal stage or theodolite on a rigid tripod. Details of its design and operation are described. --M. Russell.

1-1602. Wells, John W., and George W. White. BIOGRAPHIES OF GEOLOGISTS: Ohio Jour. Sci., v. 58, no. 5, p. 285-98, Sept. 1958.

An annotated bibliography of 202 biographies and autobiographies of geologists.--P. Smyth.

AUTHOR INDEX